MILK RIVER MITIGATION MEASURES STUDY

FINAL REPORT

Montana Reserved Water Rights Compact Commission

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Milk River Mitigation Measures Study

Final Report

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Montana Reserved Water Rights Compact Commission

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REPORT SUMMARY

The Montana Reserved Water Rights Compact Commission (RWRCC) is investigating structural and non-structural measures to mitigate the impacts that the Fort Belknap compact may have on water availability throughout the basin. Though future development and use of water by the Fort Belknap Tribe is unknown, the compact calls for the mitigation of 35,000 acre-feet of water. The mitigation measures that are currently under investigation by the RWRCC are:

(1) Installing a 50 cfs pump lift at Nelson Reservoir,
(2) Rehabilitating Dodson South Canal,
(3) Installing a secondary dam at the upper end of Nelson Reservoir, and
(4) Enlarging Fresno Reservoir.

Each of these measures would be designed and operated to increase management flexibility within the entire Milk River Project, provide more water and/or a more stable water supply, and enhance fish and wildlife habitat in and around Bowdoin National Wildlife Refuge, Nelson Reservoir, Big McNeil Slough, and/or Hewitt Lake National Wildlife Refuge.

Preliminary designs and cost estimates were developed, and potential environmental impacts were evaluated for the first 3 of these measures. Insufficient information was available at the time of this study for evaluating Fresno Reservoir, so this project is not addressed further in this report. Preliminary cost estimates are presented in the table below.

	Estimated Construction Cost	Estimated Total Project Cost
50 cfs Nelson Pump Lift Alternatives	\$590,000 to \$915,000	\$715,000 to \$1,186,500
Dodson South Canal Rehabilitation	\$425,000 to \$510,000	\$525,000 to \$630,000
McNeil Slough 50 cfs Pumps [1]	\$1,380,000 to \$1,650,000	\$1,660,000 to \$2,000,000
McNeil Slough 5 cfs Pump	\$175,000 to \$210,000	\$225,000 to \$270,000
Nelson Secondary Dams	\$2,775,000 to \$3,330,000	\$4,400,000 to \$5,500,000

[1] Includes \$500,000 to rebuild Oxarart Dam

Initial investigations indicate that the proposed mitigation measures would provide multiple benefits to fisheries, wildlife habitat, and recreational opportunities in the region. Of particular note would be the restoration of Big McNeil Slough and the ability to address salinity issues at Bowdoin NWR. Environmental issues of concern include potential impacts to fisheries in the Milk River and Nelson Reservoir and to threatened and endangered species that are present in the area.

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1.0 INTRODUCTION

1.1 Background

1.1.1 The Milk River Project
The Milk River Project provides irrigation water for more than 120,000 acres of land across north central Montana. Facilities within the project include Lake Sherburne, Nelson, and Fresno storage reservoirs; St. Mary, Swift Current, Paradise, Dodson, and Vandalia diversion dams; and hundreds of miles of canals, laterals, and drains. (USBR 2003) A map of the Milk River Project is provided in Figure 1.1.

The Dodson Diversion Dam is located on the Milk River about 5 miles west of Dodson, Montana (see Figure 1.2). This dam facilitates diversion of water from the Milk River into both the Dodson North Canal and the Dodson South Canal. The Dodson South Canal has a capacity of about 500 cfs and provides water to the Malta Irrigation District (ID), Bowdoin National Wildlife Refuge (NWR), and Nelson Reservoir. (USBR 2003)

Nelson Reservoir is an off-stream storage reservoir located about 20 miles northeast of Malta, Montana (see Figure 1.3). It has a capacity of 79,200 acre-feet and provides water to the Malta ID and Glasgow ID. The Nelson North Outlet Works (see Photos 1 and 2) is equipped with slide gates which regulate discharge out of the reservoir and into the 3,200-foot North Outlet Canal which then discharges through a drop structure (see Photos 3 and 4) into the Milk River. The South Outlet Works is also equipped with slide gates which regulate the discharge of water into the Nelson South Canal. (USBR 2003)

The Montana Reserved Water Rights Compact Commission (RWRCC) is investigating structural and non-structural measures to mitigate the impacts that the Fort Belknap compact may have on water availability throughout the basin. Though future development and use of water by the Fort Belknap Tribe is unknown, the compact calls for the mitigation of 35,000 acre-feet of water.

1.2 Proposed Mitigation Measures

Four mitigation measures that are currently under investigation by the RWRCC are:
(1) Installing a pump lift at Nelson Reservoir,
(2) Rehabilitating Dodson South Canal, and
(3) Installing a secondary dam at the upper end of Nelson Reservoir,
(4) Enlargement of Fresno Reservoir.

Each of these measures would be designed and operated to increase management flexibility within the entire Milk River Project, provide more water and/or a more stable source of water to downstream users, and enhance fish and wildlife habitat in and around Bowdoin National

Wildlife Refuge, Nelson Reservoir, Big McNeil Slough, and/or Hewitt Lake National Wildlife Refuge.

1.3 Purpose of the Report

This report is intended to provide the RWRCC with brief descriptions of the proposed potential mitigation measures along with preliminary information describing project costs, issues, and impacts. Impacts to the Bowdoin National Wildlife Refuge (NWR) are addressed in a separate section of the report. The information in this report is intended to assist the RWRCC in their future cost-share negotiations among State, Federal, and Tribal government entities.

Note: Information regarding the enlargement of Fresno Reservoir was not available before the completion of this study, so this proposed mitigation measure is not addressed in this report.

2.0 NELSON RESERVOIR PUMP LIFT

2.1 Project Description

Nelson Reservoir is currently filled with Milk River water via the Dodson South Canal, which also provides water to Bowdoin National Wildlife Refuge. The Nelson Reservoir Pump Lift project would involve installing facilities to pump available water out of the Milk River and/or Big McNeil Slough into Nelson Reservoir. The purposes of the pumping unit would be to capture water in the Milk River that would otherwise flow past the reservoir; increase operational flexibility in Nelson Reservoir, Dodson South Canal, and Fresno Reservoir; and allow for more water from the Dodson South Canal to be diverted in Bowdoin NWR.

The location and size of the proposed pumping facilities are currently under investigation. There are currently three alternatives under consideration. The first alternative is a pair of 50 cfs pumping units, with one unit located at each end of the Nelson Reservoir North Outlet Canal. Under this alternative, two options have been developed for pumping water from the Milk River into the canal and for pumping water from the canal and into the reservoir. The second alternative is a 50 cfs pumping unit in McNeil Slough which would also involve the re-construction of Oxarart Dam. The third alternative is a 5 cfs pumping unit in McNeil Slough. Figure 1.3 illustrates the locations of the proposed pumping units.

2.1.1 50 cfs Pumping Units located in Nelson North Outlet Canal

The first alternative is to construct a pair of 50 cfs capacity pumping units, one on the Milk River near the location where the Nelson North Outlet Canal enters the river, and the other at the North Outlet Works of the reservoir, using the outlet canal as a means of conveyance. Water would be pumped from the river into two pipelines which would discharge water into the outlet canal (creating a reverse flow in the outlet canal), and then pumped again from the outlet canal and up into the reservoir.

Two alternatives were considered for pumping water from the Milk River into the canal: (1) a double wet well system diverting water near the outlet tube of the drop structure, and (2) a series of 5 floating pumps at the Cree Crossing. The wet well pumping unit would consist of two 25 cfs pumps (sumps and vertical turbine pumps) located on either side of the discharge end of the North Outlet Canal (see Photo 4). A diagram of the proposed pumping unit is provided in Figure 2.3. The sumps would consist of a wet well of arch concrete pipe and a screened horizontal inlet pipe. Each pump would require a lift of 55 feet and about 170 hp of energy. The energy source would be natural gas, which is a readily available and economical energy source in this region. The pump engines would allow a variable speed to be obtained economically, which is important for this application. Pumped water would discharge into the basin upstream of the Nelson North Outlet Canal's drop structure (see Photo 3), above the maximum water surface. Overflow type slide gates would be installed in the existing stop plank grooves within the drop structure if needed to provide for 50 cfs of overflow capacity. This overflow may be needed in the event that the pumps at the North Outlet Works shut down while the Milk River pumps continue to operate. Drawings of the proposed modifications to this structure are provided in Figure 2.4. A hydraulic analysis of the reverse flow condition in the North Outlet Canal is provided in Appendix B.

An alternative to the Milk River pumping unit described above is to use a centrifugal pump and natural gas engine that would be mounted on a skid with a floating screened suction pipe extending into the Milk River. Five such units would be installed near the Cree Crossing Bridge (see Photo 5). A photo showing an example of a floating pump is provided in Figure 2.5.

The pumping unit in the North Outlet Works would consist of two 25 cfs pumps installed in the existing well of the outlet works (see Photo 3). A drawing of this pumping unit is provided in Figure 2.1. If this location is unworkable, wet well sumps similar to the Milk River pumping unit would be constructed in the North Outlet Canal downstream of the outlet conduit for the North Outlet Works (see Photo 4). The pumping unit for the alternative location is illustrated in Figure 2.2. The pumps would require 55 hp to lift the water 17 feet Pumped water would be discharged to the basin in front of the existing gates. These pumps would also be powered by natural gas engines. The pumps would be operated for short periods of time over the course of the year whenever excess flows are available, but primarily in the spring and fall.

2.1.2 50 cfs Pumping Unit located in Big McNeil Slough

Another alternative under consideration is to rebuild the old Oxarart Dam in McNeil Slough, and install five skid-mounted centrifugal pumps and natural gas engines with a floating screened suction pipes extending into the Milk River at Cree Crossing (see Photo 5 and Photo 6). These pumps will move water from the Milk River through a pipeline and into Big McNeil Slough. Water would then be pumped out of the upper end of the slough and into a ditch, which would discharge into Nelson Reservoir. The pumping unit would be operated when water is available, primarily in the spring and fall. A photo showing an example of a floating pump is provided in Figure 2.5.

2.1.3 5 cfs Pumping Unit located in Big McNeil Slough

The third alternative under consideration is to construct a 5 cfs pumping unit in Big McNeil Slough, near the Oxarart Dam site, to capture reservoir leakage and other available water. Like the wet well sumps described previously, this pump would be placed in a vertical wet well sump and inlet pipe leading to the slough. The design would be such that wintertime pumping could occur.. This pumping unit would be operated more or less continuously throughout the year whenever sufficient water is available.

2.2 Water Availability

Water availability was evaluated using a spreadsheet developed by RWRCC that models the portion of the Milk River project from Dodson Diversion down to the Tampico gage. The model is based on 14 years (1987 - 2002) of daily flow data from gages in the Milk River and a set of decision-making equations based on the assumptions listed below. A more detailed explanation of the model can be found in Appendix A.

- Pumping can only occur between March 1st and November 30th (not in the winter)
- Pump capacity is 50 cfs (or 5 cfs for the smaller Big McNeil Slough alternative)
- A minimum of 10 cfs must be left in the Milk River below Nelson Reservoir (as measured by the gages at Juneburg Bridge and/or Tampico)
- When additional water is diverted from the Milk River into the enlarged Dodson South Canal (see Section 3.0), that water is not available to the Nelson Pump Lift. This includes water diverted into the Canal that is later diverted into Bowdoin NWR.

Based on these assumptions, model results indicate that water would be available for some level of pumping (up to the maximum of 50 cfs) for an average of about 155 days in the year for a total of 13,520 acre-feet/year without the Dodson South Canal rehabilitation (see Section 3.0) and 10,870 acre-feet/year with the Dodson South Canal rehabilitation. It must be noted, however, that actual management of the Milk River project with such a pumping unit in place would likely lead to the development of different operating criteria with different results.

2.3 Potential Environmental Impacts

Each of the alternatives proposed for the Nelson Pump Lift have the potential to create both positive and negative environmental impacts. The lists provided below represent a summary of the results of preliminary environmental investigations and comments provided by personnel from State and Federal agencies, the irrigation districts, and local tribes.

2.3.1 Potential Positive Impacts

? The alternatives calling for a 50 cfs pumping unit located in Big McNeil Slough includes rebuilding the Oxarart Dam which would allow for the restoration of the former Big McNeil Slough fishery which was lost when the Oxarart Dam failed in the late 1970's. This benefit would only occur if water levels in the slough remained relatively constant. (See Section 5.3 for additional information on Big McNeil Slough)

? Nelson Reservoir is known to leak water at rates estimated to range from 10 to 80 cfs. Leakage, combined with reservoir releases and evaporation, leads to fluctuations in reservoir volumes of 20,000 to 40,000 acre-feet over the year. The pumping unit could be used to stabilize water levels and thus provide a more stable habitat for wildlife around the reservoir. (See Section 5.1 for additional information on Nelson Reservoir)

? A pumping unit would increase operational flexibility of the entire Milk River Project, including the ability to deliver water to the Bowdoin NWR. (See Section 5.2 for additional information on Bowdoin NWR)

? The pumping unit could help to raise the water level in the reservoir as high as possible before the start of Piping Plover nesting season (approximately May 15th) and maintain maximum levels after that date. (See Section 5.6.1 for additional information on the Piping Plover issue.)

? Filling Nelson Reservoir by May 15th each year would also help to stabilize water levels during the walleye spawning period.

? Adding more water to Nelson Reservoir would benefit the walleye fishery and recreational use of that resource.

? This project could deliver enough additional water for Nelson Reservoir such that some deliveries from Dodson South Canal could be diverted to Bowdoin NWR with benefits for waterfowl, colonial nesting birds such as American white pelicans and great blue herons, and for many other marsh and water birds. Bowdoin currently experiences water shortages which can initiate botulism outbreaks and can kill thousands of birds. Maintaining a higher water level at cooler temperatures could lesson the chance and severity of botulism outbreaks.

? The Milk River below Nelson Reservoir is home to numerous native fish, including Species of Special Concern and Threatened or Endangered Species. The Nelson Pump Lift could be operated to better regulate releases to the Milk River to benefit fisheries.

2.3.2 Potential Negative Impacts

? Any changes in reservoir operations have the potential to result in a negative impact to habitat, wildlife, and fisheries that are adapted to historical operation patterns. Such impacts could occur in and around Nelson Reservoir, McNeil Slough, and the Milk River.
? The greatest benefit from a 50 cfs pumping unit would derive from operating the pump whenever water is available in the Milk River. However, a 50 cfs pumping unit has the potential to raise water levels in the reservoir, particularly when combined with inflows from Dodson South Canal, snowmelt, or rain. If water levels in the reservoir are raised after Piping Plover nests are established, such nests could be inundated. (See Section 5.6.1 for additional information on the Piping Plover.) This may be a moot issue, since pumping would be largely or completely offset by on-going leakage and evaporation.
? A 50 cfs pumping unit combined with reconstruction of Oxarart Dam in Big McNeil Slough would result in a dramatic increase in the volume of water stored in the Slough, and thus a dramatic change in existing habitat. Such a change could result in a negative impact to habitat and wildlife that have adapted to lower water conditions.
? The 50 cfs pumping in Big McNeil Slough would pump an average of 13,520 acre-feet of water out of the slough each year over approximately 160 days, primarily in the spring and fall. Operation of the pump has the potential to create a local disturbance.
? The 5 cfs pumping unit in Big McNeil Slough near Oxarart Dam would pump an average of 2,056 acre-feet of water out of the slough each year over approximately 190 days, primarily in the spring and fall. Operation of the pump has the potential to create a local disturbance.
? Diverting water from the Milk River could have a negative impact to Milk River fisheries. Both the amount and the timing of the diversions would have to be evaluated relative to selected fish species. This section of the Milk River contains numerous native species of fish, including Species of Special Concern. The lower end of the Milk River, where joins the Missouri, may provide habitat to both Pallid Sturgeon and Paddlefish.
? The Fort Peck Reservation, located on the Milk River downstream from Nelson Reservoir, considers the Milk River and important Paddlefish fishery. The 50 cfs pumping unit would divert water from the Milk River that would otherwise flow past the Reservation.
? Construction of a pumping unit in Big McNeil Slough would cause localized disturbance of an existing wetland.
? Operation of the pumping unit requires consumption of energy.
? Fish could become entrained in the pumps, thus harming the local fishery. This could be mitigated with proper design of the pump intake.
? Sediment from the Milk River could get into McNeil Slough.
? Sediment from McNeil slough could get into Nelson Reservoir.
? The alternative calling for a pumping unit located in Big McNeil Slough includes the reconstruction of Oxarart Dam and the re-creation of the former Big McNeil Slough fishery, which was lost when the Oxarart Dam failed in the late 1970's. However, the benefits to the local fishery would be lost if operation the diversion dam caused dramatic changed in the water levels in the slough. This problem could be avoided through appropriate management. (See Section 5.3 for additional information on Big McNeil Slough)
? Sediments from the Milk River would accumulate in the Nelson North Outlet Canal. These sediments would be flushed out with high flow discharges from the reservoir at least once a year. The accumulated sediments would be discharged into the Milk River causing short-term water quality problems and potentially long-term problems downstream depending on where these sediments settle-out.

2.4 Additional Considerations

- The reservoir is estimated to leak at a rates ranging from 10 to 80 cfs, thus pumping water at 50 cfs would not result in a net gain of 50 cfs (100 acre-feet of water per day).
- Any benefits to wildlife habitat and fisheries in the area would also generate benefits to recreation and the recreation-based economy.

2.5 Project Costs

The costs for the Nelson Pump Lift are estimated to range from $650,000 to $780,000 for construction and from $775,000 to $930,000 for total project cost. The low ends of these ranges are based on taking the estimated costs for the lowest cost alternatives and rounding up to the nearest $25,000. The high ends of these ranges are computed by adding 20% to the low ends. The estimates or opinion of construction and total project costs for the various alternatives to pump water from the Milk River into Nelson Reservoir and are presented in the Table 2.1 through Table 2.6. Please be aware that the alternatives using the North Outlet Canal require a combination of a Milk River pumping unit (alternatives presented in Table 2.1 and Table 2.2) and a North Outlet Works pumping unit (alternatives presented in Table 2.3 and Table 2.4).

The costs are based on State entity funding and supervision and the generally accepted design considerations for private industry. Unit costs are based Montana Department of Transportation bid tabulations, quotes from suppliers, National Cost Estimating Software, and experience with area contractors. The unit costs are typical of early 2003 values. Costs for inflation, interest during construction and R.O.W.-land purchase are not included. The following tables summarize the opinion of costs.

The following list details some of the assumptions and considerations which affect costs.

- Use of standard brass trim on pumps
- Automotive type motors
- Precast concrete pipe for sump
- Outdoor plants with shading
- Minimal Security and lighting facilities
- Local contractors complete the work
- No unusual foundation or dewatering problems
- Use of existing conveyance facilities
- USBR cooperation
- Inflation remains low
- Less than 1 year construction time

Table 2.1 Cost Estimates for Nelson Pump Lift - Nelson North Outlet Canal
Milk River Unit: Sump and Vertical Turbine Pump below Drop Structure

ITEM	BASIS	QTY	UNIT	UNIT PRICE	TOTAL
Existing Canal Outlet Structure Improvements					
New slide gate on drop structure	Quote	3	EA	$9,200	$27,600
Steel bar screen replacement	$/lbs. Bid	1	EA	$1,500	$1,500
Rip rap at drop structure	MDOT bid tab	300	TON	$27	$8,100
Installation by contractor	National	5	DA	$500	$2,500
Pump Station Wetwell					
Reinforced concrete arches - 73"	Quote	96	VF	$120	$11,520
Concrete ends and base	Quote	4	EA	$400	$1,600
Seccurity fence and lights	Estimate	1	LS	$10,000	$10,000
Concrete pipe, 42" dia, Class V pipe (OD 52")	Quote	60	LF	$85	$5,100
Excavation	M & M *	842	CY	$9	$7,578
Dewatering	National	1	LS	$25,000	$25,000
Coffer dam	National	1	LS	$2,500	$2,500
Installation by contractor	National	28	DA	$500	$14,000
Pump Station Equipment (2 @ 25 CFS)					
Peerless Vert. Turbin pump, model 26 HH and 20" Stee	Quote	2	EA	$70,000	$140,000
Amarillo right angle reduction gear Model 300, ratio 4:2	Quote	2	EA	$7,730	$15,460
Installation by contractor	National	3	DA	$500	$1,500
Power Supply					
Natural gas chev. Engine 496 c.i.,170 hp continuous	Quote	2	EA	$5,300	$10,600
Heat exchanger	Quote	2	EA	$600	$1,200
Connect natural gas line to engine	Guess	1	LS	$1,000	$1,000
Installation by contractor	National	2	DA	$500	$1,000
Transmission Main					
Pipe, 32" HDPE, SDR 32.5 plus installation	$/lbs. Bid	500	LF	$60	$30,000
Increaser, HDPE 20" to 30"	Quote	2	EA	$500	$1,000
Excavation	M & M *	370	CY	$7	$2,590
Compacted backfill	M & M *	130	CY	$5	$650
Backfill	M & M *	150	CY	$3	$450
Subtotal					**$322,448**
Contract Requirement					
Mobilization Taxes, Bonds, Insurance, etc				5%	$16,122
Contractor Overhead and Profit				20%	$64,490
Subtotal					**$403,060**
Contingencies				20%	$80,612
CONSTRUCTION SUBTOTAL					**$483,672**
Final Engineering Report	Private	1	LS	$5,000	$5,000
Geotechnical	Private			2%	$9,673
Surveying	Private			2%	$9,673
Permitting	Private			2%	$9,673
Engineering Design	Private			15%	$72,551
Construction Oversight	Private			2%	$9,673
Environmental Evaluation	State Contract			5%	$24,184
TOTAL ESTIMATED PROJECT COST					**$624,100**

M & M, Unit price obtained from Morrison Maierle, Inc Detailed Cost Estimates for "Nelson Reservoir Pumping Unit Design and Construction Phase I: Final Engineering Report", Renewable Resources Grant Application, May 15, 2002.

Table 2.2 Cost Estimates for Nelson Pump Lift – Nelson North Outlet Canal Milk River Unit: Floating Pump Station Alternate

ITEM	BASIS	QTY	UNIT	UNIT PRICE	TOTAL
Existing Canal Outlet Structure Improvements					
New slide gate on drop structure	Quote	3	EA	$9,200	$27,600
Steel bar screen replacement	Steel weight	1	EA	$1,500	$1,500
Rip rap at drop structure	MDOT Bid Tab	300	TON	$27	$8,100
Installation by contractor	National	5	DA	$500	$2,500
Pump Station Equipment (5 @ 10 CFS)					
Cornell pump Model 10YB-F18	Quote	5	EA	$8,630	$43,150
Ames floating station with self-cleaning screen	Quote	5	EA	$16,910	$84,550
Installation by contractor	National	5	EA	$2,500	$12,500
Power Supply					
Natural gas chev. Engine 454 c.I., 85 hp continuous	Quote	5	EA	$4,195	$20,975
Heat exchanger	Quote	5	EA	$400	$2,000
Connect natural gas line to engine	Estimate	1	LS	$2,000	$2,000
Installation by contractor	National	2	DA	$500	$1,000
Transmission Main					
Pipe, 32" HDPE, SDR 32.5 plus installation	$/lbs. Bid	350	LF	$60	$21,000
Increaser, HDPE 20" to 30"	Quote	2	EA	$500	$1,000
Excavation	M & M *	370	CY	$7	$2,590
Compacted backfill	M & M *	130	CY	$5	$650
Backfill	M & M *	150	CY	$3	$450
Subtotal					**$231,565**
Contract Requirement					
Mobilization Taxes, Bonds, Insurance, etc				5%	$11,578
Contractor Overhead and Profit				20%	$46,313
Subtotal					**$289,456**
Contingencies				20%	$57,891
CONSTRUCTION SUBTOTAL					**$347,348**
Final Engineering Report	Private	1	LS	$5,000	$5,000
Permitting	Private			2%	$6,947
Engineering Design	Private			10%	$34,735
Construction Oversight	Private			2%	$6,947
Environmental Evaluation	State Contract			5%	$17,367
TOTAL ESTIMATED PROJECT COST					**$418,344**

M & M, Unit price obtained from Morrison Maierle, Inc Detailed Cost Estimates for "Nelson Reservoir Pumping Unit Design and Construction Phase I: Final Engineering Report", Renewable Resources Grant Application, May 15, 2002.

Table 2.3 Cost Estimates for Nelson Pump Lift – Nelson North Outlet Canal North Outlet Works Unit: Alternative in Existing Well

ITEM	BASIS	QTY	UNIT	UNIT PRICE	TOTAL
Pump Station Equipment (2@ 25 CFS)					
Peerless Vert. Turbin pump, model 30HH and 24" Steel col.	Quote	2	EA	$47,000	$94,000
Amarillo right angle reduction gear Model P3, ratio 4:1	Quote	2	EA	$7,210	$14,420
Flowmeters	Quote	2	EA	$12,500	$25,000
Control wire to Milk River pumps	National	2000	ft	$3	$6,000
Steel Building	National	400	SF	$10	$4,000
Cut 24" diameter hole through concrete outlet structure	National	1	EA	$1,000	$1,000
Installation by contractor	National	5	DA	$500	$2,500
Power Supply					
Natural gas chev. Engine 262 c.I., 55hp continuous	Quote	2	EA	$2,900	$5,800
Heat exchanger	Quote	2	EA	$600	$1,200
Connect natural gas line to engine	Estimate	1	LS	$1,000	$1,000
I-Beam brace for mounting motor and engine to ontlet deck	Steel weight	2	EA	$2,000	$4,000
Installation by contractor	National	2	DA	$500	$1,000
Subtotal					**$159,920**
Contract Requirement					
Mobilization Taxes, Bonds, Insurance, etc				5%	$7,996
Contractor Overhead and Profit				20%	$31,984
Subtotal					**$199,900**
Contingencies				20%	$39,980
CONSTRUCTION SUBTOTAL					**$239,880**
Final Engineering Report	Private	1	LS	$5,000	$5,000
Permitting	Private			2%	$4,798
Engineering Design	Private			10%	$23,988
Construction Oversight	Private			2%	$4,798
Environmental Evaluation	State Contract			5%	$11,994
TOTAL ESTIMATED PROJECT COST					**$290,457**

Table 2.4 Cost estimates for Nelson Pump Lift – Nelson North Outlet Canal North Outlet Works Unit: Alternative below Outlet Works

ITEM	BASIS	QTY	UNIT	UNIT PRICE	TOTAL
Pump Station Wetwell					
Reinforced concrete arches - 73"	Quote	25	VF	$120	$3,000
Concrete end base	Quote	2	EA	$350	$700
Concrete end - with 42" diameter opening (Modified type II)	Quote	2	EA	$400	$800
Concrete pipe, 42" dia, Class V pipe (OD 52")	Quote	110	LF	$85	$9,350
Excavation	M & M *	840	CY	$9	$7,560
Dewatering	National	1	LS	$5,000	$5,000
Installation by contractor	crew days	20	DA	$500	$10,000
Pump Station Equipment (2 @ 25 CFS)					
Peerless Vert. Turbine pump, model 30 HH, 20" Steel col.	Quote	2	EA	$94,528	$189,056
Amarillo right angle reduction gear Model P-3, ratio 5:1	Quote	2	EA	$7,730	$15,460
Hard wire controls	National	1	LS	$10,000	$10,000
Installation by contractor	crew days	3	DA	$500	$1,500
Power Supply					
Natural gas chev. Engine 262 c.i., 68 hp continuous	Quote	2	EA	$3,450	$6,900
Heat exchanger	Quote	2	EA	$600	$1,200
Connect natural gas line to engine	Guess	2	LS	$1,000	$2,000
Installation by contractor	crew days	4	DA	$500	$2,000
Transmission Main					
Pipe, 32" HDPE, SDR 32.5 plus installation	Quote	300	LF	$35	$10,500
Pipe, 20" HDPE, SDR 32.5 plus installation	Quote	150	LF	$30	$4,500
Increaser, HDPE 20" to 32", SDR 32.5	Quote	1	EA	$600	$600
Tee 20" x 20" x 32"	Quote	1	EA	$400	$400
Excavation	M & M *	900	CY	$7	$6,300
Compacted backfill	M & M *	700	CY	$5	$3,500
Subtotal					**$290,326**
Contract Requirement					
Mobilization Taxes, Bonds, Insurance, etc				5%	$14,516
Contractor Overhead and Profit				20%	$58,065
Subtotal					**$362,908**
Contingencies				20%	$72,582
CONSTRUCTION SUBTOTAL					**$435,489**
Final Engineering Report	Private	1	LS	$5,000	$5,000
Geotechnical	Private			2%	$8,710
Surveying	Private			2%	$8,710
Permitting	Private			2%	$8,710
Engineering Design	Private			15%	$65,323
Construction Oversight	Private			2%	$8,710
Environmental Evaluation	State contract			5%	$21,774
TOTAL ESTIMATED PROJECT COST					**$562,426**

M & M, Unit price obtained from Morrison Maierle, Inc Detailed Cost Estimates for "Nelson Reservoir Pumping Unit Design and Construction Phase I: Final Engineering Report", Renewable Resources Grant Application, May 15, 2002.

Table 2.5 Cost estimates for Nelson Pump Lift - McNeil Slough 50 cfs Pump Station

ITEM	BASIS	QTY	UNIT	UNIT PRICE	TOTAL
Pump Station Equipment (5 @ 10 CFS)					
Cornell pump Model 10YB-F18	Quote	5	EA	$8,630	$43,150
Ames floating station with self-cleaning screen	Quote	5	EA	$16,910	$84,550
Installation by contractor	National	5	EA	$2,500	$12,500
Power Supply					
Natural gas chev. Engine 454 c.I., 85 hp continuous	Quote	5	EA	$4,195	$20,975
Heat exchanger	Quote	5	EA	$400	$2,000
Connect natural gas line to engine	Estimate	1	LS	$2,000	$2,000
Installation by contractor	National	2	DA	$500	$1,000
Slough Pump Station Wetwell					
Reinforced concrete arches - 73"	Quote	42	VF	$120	$5,040
Concrete end base	Quote	2	EA	$350	$700
Concrete end - with 42" diameter opening (Modified type II)	Quote	2	EA	$400	$800
Concrete pipe, 42" dia, Class V pipe (OD 52")	Quote	130	LF	$85	$11,050
Excavation	M & M **	842	CY	$9	$7,578
Dewatering	National	1	LS	$10,000	$10,000
Installation by contractor	National	28	DA	$500	$14,000
Slough Pump Station Equipment (2@ 25 CFS)					
Peerless Vert. Turbin pump, model 26 HH and 20" Steel column	Quote	2	EA	$55,000	$110,000
Amarillo right angle reduction gear Model P-5, ratio 3.5:1	Quote	2	EA	$11,450	$22,900
Installation by contractor	National	3	DA	$500	$1,500
Slough Power Supply					
Natural gas chev. Engine 454 c.i., 200 hp continuous	Quote	2	EA	$9,950	$19,900
Heat exchanger	Quote	2	EA	$600	$1,200
Connect natural gas line to engine	Guess	1	LS	$1,000	$1,000
Installation by contractor	National	2	DA	$500	$1,000
Transmission Main					
Pipe, 32" HDPE, SDR 32.5 plus installation	$/lbs. Bid	3500	LF	$60	$210,000
Increaser, HDPE 20" to 30"	Quote	2	EA	$500	$1,000
Excavation	M & M**	350	CY	$7	$2,450
Compacted backfill	M & M**	250	CY	$5	$1,250
Outlet Protection	M & M**	1	LS	$5,500	$5,500
Subtotal					**$587,543**
Contract Requirement					
Mobilization Taxes, Bonds, Insurance, etc				5%	$29,377
Contractor Overhead and Profit				20%	$117,509
Subtotal					**$734,429**
Contingencies				20%	$146,886
CONSTRUCTION SUBTOTAL					**$881,315**
Final Engineering Report	Private	1	LS	$5,000	$5,000
Geotechnical	Private			2%	$17,626
Surveying	Private			2%	$17,626
Permitting	Private			4%	$35,253
Engineering Design	Private			15%	$132,197
Construction Oversight	Private			2%	$17,626
Environmental Evaluation	State contract			5%	$44,066
TOTAL ESTIMATED PROJECT COST					**$1,150,709**

M & M, Unit price obtained from Morrison Maierle, Inc Detailed Cost Estimates for "Nelson Reservoir Pumping Unit Design and Construction Phase I: Final Engineering Report", Renewable Resources Grant Application, May 15, 2002.

Table 2.6 Cost estimates for Nelson Pump Lift - McNeil Slough 5 cfs Pump Station

ITEM	BASIS	QTY	UNIT	UNIT PRICE	TOTAL
Pump Station Wetwell					
Reinforced concrete arches - 44"	Quote	23	VF	$55	$1,265
Concrete end base	Quote	1	EA	$150	$150
Concrete end - with 24" diameter opening (Modified type II)	Quote	1	EA	$150	$150
Concrete pipe, 18" dia, Class III pipe (OD 24")	Quote	110	LF	$12	$1,320
Excavation	M & M *	140	CY	$9	$1,260
Dewatering	National	1	LS	$2,000	$2,000
Installation by contractor	crew days	5	DA	$500	$2,500
Pump Station Equipment					
Peerless Vert. Turbine pump, model 16 HXB, 12" Steel column	Quote	1	EA	$27,000	$27,000
Amarillo right angle reduction gear Model 100A, ratio 3:2	Quote	1	EA	$2,320	$2,320
Installation by contractor	crew days	1	DA	$500	$500
Power Supply					
Natural gas chev. Engine 350 c.i., 65 hp continuous	Quote	1	EA	$3,450	$3,450
Heat exchanger	Quote	1	EA	$600	$600
Connect natural gas line to engine	Guess	1	LS	$1,000	$1,000
Installation by contractor	crew days	2	DA	$500	$1,000
Transmission Main					
Pipe, 16" HDPE, SDR 32.5 plus installation	$/lbs. Bid	4000	LF	$15	$60,000
Increaser, HDPE 12" to 16", SDR 32.5	Quote	1	EA	$500	$500
Excavation	M & M *	900	CY	$7	$6,300
Compacted backfill	M & M *	700	CY	$5	$3,500
Subtotal					**$114,815**
Contract Requirement					
Mobilization Taxes, Bonds, Insurance, etc				5%	$5,741
Contractor Overhead and Profit				20%	$22,963
Subtotal					**$143,519**
Contingencies				20%	$28,704
CONSTRUCTION SUBTOTAL					**$172,223**
Final Engineering Report	Private	1	LS	$5,000	$5,000
Geotechnical	Private			2%	$3,444
Surveying	Private			2%	$3,444
Permitting	Private			2%	$3,444
Engineering Design	Private			15%	$25,833
Construction Oversight	Private			2%	$3,444
Environmental Evaluation	State contract			5%	$8,611
TOTAL ESTIMATED PROJECT COST					**$225,445**

M & M, Unit price obtained from Morrison Maierle, Inc Detailed Cost Estimates for "Nelson Reservoir Pumping Unit Design and Construction Phase I: Final Engineering Report", Renewable Resources Grant Application, May 15, 2002.

3.0 REHABILITATION OF THE DODSON SOUTH CANAL

3.1 Project Description

The Dodson South Canal Rehabilitation project would involve aggressive cleaning and re-grading of the canal to increase its capacity by 125 cfs (from 450 cfs up to 575 cfs). The concept is to increase the capacity of the canal as much as possible without having to replace existing structures. A map of the reach of the canal that would be rehabilitated is presented in Figure 3.1. A hydraulic analysis of a representative section of the Dodson South Canal is presented in Appendix C. A detail analysis of the entire canal was not completed.

3.2 Water Availability

Water availability for increased diversions into Dodson South Canal was evaluated using a spreadsheet developed by RWRCC that models the portion of the Milk River project from Dodson Diversion down to the Tampico gage. The model is based on 14 years (1987 - 2002) of daily flow data from gages in the Milk River and a set of decision-making equations based on the assumptions listed below. A more detailed explanation of the model can be found in Appendix A.

? Additional diversions into the canal may only occur between March 30th and November 3rd (not in the winter)

? There must be at least 50 cfs of additional water physically available in the Milk River before additional diversions could occur, as measured by the gage located below the dam

? A minimum of 10 cfs must be left in the Milk River below Dodson Diversion Dam

? A maximum of 125 cfs of additional water could be diverted into the enlarged canal

? All of the additional water diverted into the canal will be sent to Nelson Reservoir or Bowdoin National Wildlife Refuge

? Water losses from the additional diversions would be small compared to losses occurring from existing diversions

Based on these assumptions, model results indicate that an additional 18,797 acre-feet/year could be diverted into Dodson South Canal if it was rehabilitated. It must be noted, however, that actual management of the Milk River project with the canal rehabilitation completed would likely lead to the development of different operating criteria with different results.

3.3 Potential Environmental Impacts

Cleaning and regrading the canal has the potential to create both positive and negative environmental impacts. Evaluation of these impacts would require a reach-by-reach analysis. The lists provided below represent a summary of the results of preliminary environmental investigations and comments provided by personnel from State and Federal agencies, the irrigation districts, and local tribes.

3.3.1 Potential Positive Impacts

? Dodson South Canal is currently the only mechanism for delivering water to Nelson Reservoir. It is also the primary source of water for Bowdoin NWR. Increasing the capacity of the canal would allow for greater water deliveries to Nelson Reservoir and Bowdoin NWR, creating benefits to habitats associated with each. (See Section 6 for additional information on Nelson Reservoir and Bowdoin NWR).

? Increasing the capacity of the canal will allow for increased water deliveries to Bowdoin NWR. This water could be used to flush out excessive salts present in and around the refuge.

? Cleaning and enlarging the canal could result in an increase in canal seepage, which in turn could benefit habitat along the canal. This may be moot because the proposed changes in canal cross section would not substantially change the amount of surface area through which leakage would occur.

? Cleaning and enlarging the canal could require removal of bank vegetation. Removal of riparian vegetation is a concern, but much of that vegetation is likely to be Russian Olive, an introduced tree/shrub which has rapidly expanded its range and displaced more desirable native trees and shrubs besides altering the vegetation community to the point that nest predators are now more abundant (raccoon and skunk). Olives are difficult to eradicate, and control measures are labor-intensive. Removal of the vegetation could cause some winter habitat to be lost for sharp-tailed grouse, ring-necked pheasant, white-tailed deer and many songbirds. Summer habitat, however, could be improved for nesting sharptails, waterfowl and grassland sparrows. Grassland sparrows include several species of special concern.

? Increasing the capacity of the canal will raise the water level in the reservoir as high as possible before the start of Piping Plover nesting season (approximately May 15th) and maintain maximum levels after that date. (See Section 5.6.1 for additional information on the Piping Plover issue.)

? Filling Nelson by May 15th each year would also stabilize water levels during the walleye spawning period.

3.3.2 Potential Negative Impacts

? Preliminary environmental investigations suggest that cleaning and enlarging the canal could require removal of bank vegetation. Removal of riparian vegetation could be a concern, but much of that vegetation would likely be Russian Olive, which is an introduced tree/shrub which has rapidly expanded its range and displaced more desirable native trees and shrubs besides altering the vegetation community to the point that nest predators are now more abundant (raccoon and skunk). Olives are difficult to eradicate, and control measures are labor-intensive. Removal of such vegetation could cause some winter habitat to be lost for sharp-tailed grouse, ring-necked pheasant, white-tailed deer and many songbirds. Summer habitat, however, could be improved for nesting sharptails, waterfowl and grassland sparrows. Grassland sparrows include several species of special concern.

? Increasing the capacity of the canal will allow for increased water deliveries to Bowdoin NWR. This water could be used to flush out excessive salts present in and around the refuge. There is a concern that flushing these salts could cause damage downstream. However, this problem could be mitigated through careful management.

? Increasing diversions into Dodson South Canal would reduce the amount of water flowing in the Milk River below the Dodson Diversion Dam.

? Nelson currently receives a significant sediment load from the Dodson South Canal caused by erosion of the outlet (see Photo 8), as can be seen from the formation of a delta in Nelson

Reservoir at the canal outlet. Increasing flows from Dodson would increase erosion and sediment loading of Nelson Reservoir.

- ? Fish entrainment is known to occur in Dodson South Canal under existing conditions. If diversions are increases, fish entrainment would also likely increase. This problem could be mitigated with proper screening or by re-building check structures in the ditch so as to allow trapped fish to be captured and saved.

3.4 Additional Considerations

- ? Measurements of water diverted into Dodson South Canal from the Milk River are considered to be unreliable, thus it is and will be difficult to evaluate the benefit of canal rehabilitation. It is recommended that better flow measurement facilities be installed as a part of the mitigation effort. Cost for these facilities have not been developed.

3.5 Project Costs

The costs for the Dodson South Canal rehabilitation are estimated to range from $400,000 to $475,000 for construction and from $500,000 to $600,000 for total project costs. The low ends of these ranges are based on taking the estimated costs and rounding up to the nearest $25,000. The high ends of these ranges are computed by adding 20% to the low ends. The estimates of construction and total project costs for cleaning and grading a significant portion of the Dodson South Canal are presented in Table 3.1.

The costs are based on State entity funding and supervision and the generally accepted design considerations for private industry. Unit costs are based Montana Department of Transportation bid tabulations, quotes from suppliers, National Cost Estimating Software and experience with area contractors. The unit costs are typical of early 2003 values. Costs for inflation, interest during construction and R.O.W.-land purchase are not included. A 40% contingency factor was used for this project, rather than the standard 20%, to account for the fact that cost estimates were based on a very limited survey of the canal. The following tables summarize the opinion of costs.

The following list identifies assumptions that may affect cost.

- ? District contracts for or performs work
- ? Good access, no urban problems
- ? Inflation remains low
- ? Single season construction period
- ? Proper size of excavator and bucket
- ? Off-season construction, limited construction time

Table 3.1 Cost Estimates for Dodson South Canal Rehabilitation

ITEM	BASIS	QTY	UNIT	UNIT PRICE	TOTAL
Canal enlargement, 26 miles	National	151,044	CY	$1.90	$286,984
Survey of canal	Quote	20	DA	$500	$10,000
Subtotal					**$296,984**
Contingencies				40%	$118,793
CONSTRUCTION SUBTOTAL					**$415,777**
Engineering Report	Private	1	LS	$ 25,000	$25,000
Construction Oversight by district staff	District			5%	$20,789
Environmental Evaluation	State contract			10%	$41,578
TOTAL ESTIMATED PROJECT COST					**$503,144**

4.0 SECONDARY DAM AT NELSON RESERVOIR

4.1 Project Description

A secondary dam would be constructed in the west (upper) end of Nelson Reservoir, just east of the site where Dodson South Canal discharges into the reservoir (see Photo 7). The purpose of the secondary dam would be to increase the total capacity of Nelson Reservoir, particularly at the west end which is thought to leak less than the rest of the reservoir. The increase in capacity would be most important for long-term carry-over storage needed in very dry years. The dam would be located to capture inflows from Dodson South Canal. Plan views of the proposed secondary dam and small dike are presented in Figure 4.1.

The secondary dam would be approximately 1,970 feet wide and would raise the water surface in the west end of the reservoir by about 15 feet. Raising water levels in this portion of the reservoir would also require the installation of another small dam in the swale that lies to the northwest to prevent overflow in this topographic low.

Water would be impounded by a zoned embankment with 3:1 slopes upstream and 2:1 downstream, to an elevation of 2,225 ft. A beaching slope of about 5:1 would extend from elevations 2,225 to 2,215, which would be 3 feet under the expected maximum water surface of the lower reservoir. The beaching slope would be protected with local gravel placed over geofabric. The top width of the dam would be approximately 20 feet. Riprap on the upstream slope would consist of locally gathered rock from the glacial till prevalent in this region. Figure 4.2 illustrates the maximum dam cross sections.

The outlet works for the dam would consist of a concrete structure and an overshot gate (see Figure 4.3). The structure would be 20 feet wide and pass 800 cfs with 5.5 feet of head. Normal capacity would be 600 cfs or equal to maximum capacity of Dodson South Canal after improvement. The 600 cfs would pass with a head of 4.5 feet over the gates. These heads should allow reasonable control of reservoir elevations and adequate energy dissipation below the structure. The 5 feet of head should allow Dodson South Canal water to be passed on to the lower reservoir without significant loss of storage in the upper reservoir basin.

The secondary dam would increase the total capacity of the reservoir by 11,245 acre-feet over the exiting capacity of 79,200 acre-feet, which is an increase of about 14%. The purpose of the secondary dam would be to increase the overall capacity of Nelson Reservoir, allowing for long term (2 to 5 year) water storage. In addition, the upper reservoir could be used to store water delivered to the reservoir from Dodson South Canal between May 15 and August 15, which is the nesting season for the endangered Piping Plover. An MOU between USBR, FWS, Malta ID, and Glasgow ID states that the water level in Nelson Reservoir must not be raised above the level attained on May 15th to avoid inundation of nests. For these reasons, the secondary dam would provide additional operating flexibility to Nelson Reservoir, Dodson South Canal, and Fresno Reservoir.

4.2 Water Availability

The secondary dam would store water delivered to Nelson Reservoir by Dodson South Canal and would increase the storage capacity of Nelson Reservoir by about 11,245 acre-feet. The enlarged reservoir created behind the secondary dam would not be subject to the water level restrictions imposed on the main body of the reservoir during piping plover nesting season.

Water availability for the secondary dam was evaluated using a spreadsheet developed by RWRCC that models the portion of the Milk River project from Dodson Diversion down to the Tampico gage. The model is based on 14 years (1987 - 2002) of daily flow data from gages in the Milk River and a set of decision-making equations based on the assumptions listed below. A more detailed explanation of the model can be found in Appendix A.

Water availability for the secondary dam is dependant, in part, on how much additional water is delivered to Nelson Reservoir after the completion of the Dodson South Canal Rehabilitation Project (see Section 3.0) and the Nelson Pump Lift Project (See Section 2.0). Modeling results indicate that the rehabilitated canal could deliver an average of 18,797 acre-feet of additional water a year. This suggests that the secondary dam could allow for the storage of about 60% of the total annual additional water that would be delivered by the rehabilitated canal each year if all of that water were delivered to Nelson Reservoir, assuming none of that water was used. However, one benefit provided by rehabilitating the canal is the ability to deliver more water more often to Bowdoin NWR.

One management scenario that has been analyzed in the model would divert a portion of the additional water in the canal to Bowdoin when Nelson Reservoir is at or above a target level of 60,000 ac-ft. When the reservoir level is at or above the target level, increasing portions of the additional water in the canal would be sent to Bowdoin until the reservoir is full, at which point 100% of the additional water would be sent to Bowdoin. Using this management scenario, an average of approximately 4,532 ac-ft of additional water would be sent to Nelson Reservoir and 14,265 ac-ft of additional water would be sent to Bowdoin and each year if both the canal rehabilitation project and the Nelson Pump Lift project were in completed. If only the canal project was completed, the additional water in the canal would provide an average of 7,923 ac-ft/year to Nelson Reservoir and 10,874 ac-ft/year to Bowdoin.

4.3 Potential Environmental Impacts

Constructing and operating a secondary dam in Nelson Reservoir has the potential to create both positive and negative environmental impacts. The lists provided below represent a summary of the results of preliminary environmental investigations and comments provided by personnel from state and federal agencies, the irrigation districts, and local tribes.

4.3.1 Potential Positive Impacts

? The upper end of the reservoir does not appear to contain Piping Plover nesting habitat. Adding capacity at the upper end of the reservoir would allow for the capture and storage of water from Dodson South Canal during the Piping Plover nesting season which is from May 15 to August 15. (See Section 5.0 for more information on Piping Plover)

? Raising the water level in the upper end of the reservoir would make it easier to move water from Nelson Reservoir to Hewitt Lake, which is a satellite National Wildlife Refuge (see Section 5.4 for more information on Hewitt Lake NWR).

4.3.2 Potential Negative Impacts

? The design for the secondary dam calls for raising water levels by 15 feet. If the water level in the upper reservoir were raised by 22 feet, it could flood some Blacktail Prairie Dog towns (candidate species use these towns). However, if water levels were raised very slowly (on the order of 2 feet per year) the dog towns would shift to avoid flooding. Preliminary investigations indicate that prairie dog towns would not be inundated.
? The area that is the proposed site for the secondary dam appears to be a key pre-spawning area for walleye, perch, and northern pike that live in Nelson Reservoir. These fish have been observed to congregate in large numbers in this area in the spring. It is possible that installation of the secondary dam would disrupt spawning cycles of these fish.

4.4 Additional Considerations

? Numerous gas wells are located in the area. It is possible that gas wells are located above the west end of the reservoir and would be flooded.
? It is estimated that Nelson Reservoir currently leaks water at rate between 10 and 80 cfs. The upper part of the reservoir, however, appears to be surrounded by tighter soils, so water stored behind the secondary dam would likely leak at a lower rate. In addition, leakage from the upper end would likely migrate back into the main body of the reservoir. Further analysis would be required to confirm these concepts.
? Nelson Reservoir has not been filled to capacity in several years. It appears that it would not be beneficial to provide additional storage unless additional water deliveries from Dodson South Canal were also provided. However, even if no additional water deliveries were made, the secondary dam would provide for additional long term (2-5 year) storage.
? Increasing the capacity of Dodson South Canal would allow for increasing water deliveries to Nelson Reservoir (and, when available, Bowdoin NWR) by an average of about 18,797 af per year over historical levels (based on modeling results). The secondary dam would allow for storage of much of this additional water.
? Water stored in the main body of the reservoir could not be pumped back behind the secondary dam, so water pumped into the reservoir by the Nelson Pump Lift could not be stored behind the secondary dam.

4.5 Project Costs

The costs for the Nelson Reservoir Secondary Dams are estimated to range from $2,775,000 to $3,330,000 for construction and from $3,575,000 to $4,290,000 for total project cost. The low ends of these ranges are based on taking the estimated costs for the lowest cost alternatives and rounding up to the nearest $25,000. The high ends of these ranges are computed by adding 20% to the low ends. The estimates or opinion of construction and total project costs have been prepared for construction of the secondary dams on the upper end of Nelson Reservoir and are presented in Table 4.1.

The costs are based on State entity funding and supervision and the generally accepted design considerations for private industry. Unit costs are based Montana Department of Transportation bid tabulations, quotes from suppliers, National Cost Estimating Software and experience with area contractors. The unit costs are typical of early 2003 values. Costs for inflation, interest during construction and R.O.W.-land purchase are not included. These costs are based on the assumption that the project is not a high-hazard dam because it is a secondary dam. The following tables summarize the opinion of costs

As with the previous estimates, the following list may affect costs.

- No unusual foundation conditions or dewatering problems
- Materials available near dam site
- Inflation remains low
- 2 year construction period
- Environmental mitigation reasonable
- Private design and contract
- Open gate outlet works
- 100 year life concrete
- USBR and Districts cooperation

Table 4.1 Cost Estimates for Nelson Reservoir Secondary Dams

ITEM	BASIS	QTY	UNIT	UNIT PRICE	TOTAL
Management of Lower Reservoir	Estimate	1	LS	$20,000.00	$20,000
Stripping Foundation, 1 foot over footprint Dam	National	400	MSF	$32.00	$12,800
Stripping Foundation, 1 foot over footprint Dike	National	60	MSF	$32.00	$1,920
Unwatering foundations and excavate core	Estimate	26,000	CY	$10.00	$260,000
Excavation, Dam 20% shrink	MDOT Bid Tab	155,640	CY	$ 2.10	$326,844
Excavation, Dike 20% shrink	MDOT Bid Tab	22,800	CY	$ 2.10	$47,880
Structural backfill	National	500	CY	$5	$2,500
Concrete, outlet works	MDOT Bid Tab	220	CY	$500	$110,000
Steel, misc. structural	National	5,000	$/lbs	$ 1.50	$7,500
Access road improvement, ± 1 mile	National	50,000	SY	$2	$100,000
Clay zone, Dam only	National	27,500	CY	$2	$55,000
Clay zone, Dike only	National	4,900	CY	$2	$9,800
Gates, overshot, furnish and install	Quote	2	EA	$75,000	$150,000
Sluce Gates, outlet pipe 2' X 2' sluice	National	2	EA	$7,850	$15,700
Earthfill, dam, backfill and compact cutoff below grade	National	26,500	CY	$3	$79,500
Earthfill, dike, backfill and compact cutoff below grade	National	2,500	CY	$3	$7,500
Sand and gravel fill place and compact, Dam	MDOT Bid Tab	43,588	CY	$ 2.40	$104,611
Sand and gravel fill place and compact, Dike	MDOT Bid Tab	12,500	CY	$ 2.40	$30,000
70 mil fabric filter placed beneath rip rap, Dam	National	1,500	SF	$ 1.25	$1,875
70 mil fabric filter placed beneath rip rap, Dike	National	550	SF	$ 1.25	$688
Sand and gravel drain furnish and place, Dam	National	5,500	CY	$10	$55,000
Sand and gravel drain furnish and place, Dike	National	1,100	CY	$10	$11,000
Rip-rap Dam	MDOT Bid Tab	9,070	CY	$35	$317,450
Rip-rap Dike	MDOT Bid Tab	3,300	CY	$35	$115,500
Subtotal					**$1,843,068**
Contract Requirement					
Mobilization Taxes, Bonds, Insurance, etc				5%	$92,153
Contractor Overhead and Profit				20%	$368,614
Subtotal					**$2,303,835**
Contingencies				20%	$460,767
CONSTRUCTION SUBTOTAL					**$2,764,602**
Final Engineering Report	Private	1	LS	$100,000	$100,000
Permitting	Private			5%	$138,230
Engineering Design	Private			10%	$276,460
USBR Oversight	USBR			35%	$967,611
Environmental Evaluation	State contract			5%	$138,230
TOTAL ESTIMATED PROJECT COST					**$4,385,132**

5.0 ADDITIONAL ENVIRONMENTAL INFORMATION

Each of the proposed mitigation measures has the potential to impact local habitats, wildlife, and fisheries. In addition, each could require permitting and would require thorough evaluation through the NEPA process. These issues have been mentioned among the lists of potential environmental impacts and are discussed in more detail in the sections below.

5.1 Nelson Reservoir

Nelson Reservoir is an important off-stream storage facility for the Milk River Project located in Phillips County about 19 miles northeast of Malta, Montana. The reservoir has a capacity of 79,200 acre-feet, a surface area of 4,320 acres, and forms 30 miles of shoreline. In addition to storing water for irrigation, the reservoir provides good recreational fishing for walleye, perch, and northern pike. (Recreation.Gov, 2003) The reservoir is formed in a natural basin whose capacity has been enlarged by backing up water behind a series of five earth-filled dikes. The primary source of water for the reservoir is the Milk River diverted at Dodson Dam and delivered by the Dodson South Canal, which discharges into the south end of the reservoir. Water stored in the reservoir can be released through the Nelson North Outlet Canal which discharges to the Milk River, or Nelson South Outlet Canal. (USBR, 1999) Figure 5.1 provides a map illustrating the major features of Nelson Reservoir.

In addition to planned releases, a significant amount of water also leaves the reservoir via leakage. It is estimated that the reservoir leaks at rates from 10 to 80 cfs. Leakage, combined with reservoir releases and evaporation, leads to fluctuations in reservoir volumes of 20,000 to 40,000 acre-feet over the year. A plot illustrating water level fluctuations in Nelson Reservoir from 1987 through 2001 is provided in Figure 5.2. If more water is kept in the upper reservoir created by the secondary dams, less loss may occur, resulting in a savings of water.

Nelson Reservoir, along with Bowdoin NWR and Hewitt Lake NWR, provides valuable aquatic and terrestrial habitat. Fisheries in Nelson include walleye, perch, and northern pike. The shores and lands surrounding the reservoir provide habitat for such notable species as piping plover (see Section 5.6.1), blacktail prairie dogs (see Section 5.6.2), black-footed ferret (endangered species), burrowing owl, mountain plover (petitioned species), ferruginous hawk, golden eagle, swift fox, horned lark, deer mouse, grasshopper mouse, and many grassland birds. (See Section 5.6)

5.2 Bowdoin Wildlife Refuge

Bowdoin National Wildlife Refuge (NWR) is made up of over 6,500 acres of wetland and almost 9,000 acres of uplands that provides resting, feeding, and breeding habitat 263 species of birds, over 26 species of mammals, and several species of reptiles, amphibians and fish. Habitat types include saline and freshwater wetlands, native prairie, dense nesting cover, and shrubs. (FWS 2003) Figure 5.3 illustrates the major features of Bowdoin NWR.

5.2.1 Wetlands

The islands, marshes, and open waters of the refuge are support a long list of wetland birds that includes American white pelicans, California gulls, ring-billed gulls, double-crested cormorants, great blue herons, Franklin's gulls, white-faced ibis, black-crowned night herons, American coots, eared grebes, sora rails, American bitterns, Canada geese, ducks, willets, marbled godwits, Wilson's phalaropes, American avocets, black-necked stilts, killdeer, upland sandpipers, and long-billed curlews. (FWS 2003)

5.2.2 Uplands

The upland habitat of the refuge provide home to sharp-tailed grouse, sage, ring-necked pheasants, gray partridge, Baird's sparrow, Sprague's pipit, grasshopper sparrow, savannah sparrow, chestnut-collared longspur, and the western meadowlark. The list of mammals at the refuge includes whitetail deer, pronghorns, mule deer, whitetail jackrabbits, mountain cottontails, Richardson ground squirrels, least and long-tailed weasels, masked shrews, mink, muskrats, a variety of mice, prairie and meadow voles, porcupines, bats, beaver, raccoons, coyotes, badgers, and striped skunks (FWS 2003).

5.2.3 Threatened and Endangered Species

Bowdoin NWR provides habitat for piping plover, black-footed ferret, bald eagle, and peregrine falcon. Some areas of the refuge have been enhanced for piping plover nesting. In 1999, a facility was constructed at Bowdoin for breeding black-footed ferret to be released on black-tailed prairie dog towns in Montana and other states. (FWS 2003)

5.2.4 Water Supply

The main source of water for the refuge is the Milk River Project. The U.S. Fish & Wildlife Service (FWS) has a water contract for 3,500 ac-ft/year from the Milk River Project, but typically receives that water in approximately 2 out of every 3 years. FWS also has purchased up to 8000 ac-ft additional water from the project in some years. Additional sources of water for the refuge include natural rain, snowmelt, and occasional flooding of Beaver Creek, and irrigation return flows.

Due to the relatively high salinity of incoming water, especially from irrigation return flow and groundwater seepage, evapoconcentration has increased the salinity of lakes and wetlands. During 1978-97, specific conductance measurements of Lake Bowdoin ranged from 548 to 60,000 mS/cm (microsiemens per centimeter) with a mean of 8,672 and a median of 7,775 mS/cm (Kendy, 1999), far exceeding the DEQ guidelines of point source discharges of 1000 mS/cm during the irrigation season and 2000 mS/cm off season (Horpstadt, 2002). Consequently, under most circumstances it appears that the refuge is not permitted to release any water.

Salinity frequently reaches concentrations considered harmful and even toxic to waterfowl production. A maximum specific conductance of 6,000 mS/cm has been recommended to maintain waterfowl production at similar wetland/prairie complexes in Montana (Kendy, 1999). That level is frequently exceeded in some of the Bowdoin ponds.

In most years, Bowdoin is water limited and functions as a closed drainage. Dissolved salts enter the refuge with canal deliveries, irrigation return flows, surface runoff, groundwater seepage, and precipitation. Water supply is approximately equal to evapotranspiration losses and there is rarely any outflow, so salts continue to accumulate. The annual salt budget for the refuge is estimated to be 17.974 million pounds (Kendy, 1999), almost 9,000 tons per year. Currently the means used for getting rid of salts is to place the saltiest water in Dry Lake, wait for it to evaporate, and let the wind blow the salt crusts away. This approach has been effective in slowing the accumulation of salts. Landowners who live down-wind continue to strenuously object to this practice.

Modeling work done by the USGS indicate that relatively low salt concentrations could be achieved and maintained if enough water were available to convert the refuge from a closed basin to a flow-through system that discharges water into Beaver Creek (Kendy, 1999). It is currently thought that it would take a total water supply of up to 14,000 ac-ft/year to create a flow-through system (per com Fritz Prellwitz, USFWS, 2003). This supply could be met by 2,000 ac-ft/year from irrigation return flows and 12,000 ac-ft/year from the Milk River project.

Water shortages at the refuge create several other environmental problems as well. Botulism outbreaks can occur at the refuge when water levels become too low, or are adjusted too quickly during times when the water is warm. Furthermore, low water levels also leave nesting islands more vulnerable to predators (per com Fritz Prellwitz, USFWS, 2003).

Increasing the water supply to Bowdoin NWR would increase waterfowl habitat, increase waterfowl production, reduce the negative impacts created by high salinity, and reduce botulism outbreaks. Without additional water, salinity levels will not improve until an unplanned flood event causes uncontrolled and potentially harmful discharges.

5.3 Big McNeil Slough

Big McNeil Slough is an old oxbow of the Milk River located just west of the Nelson North Outlet Canal for Nelson Reservoir and just south of the Milk River (see Figure 5.4). In the late 1940's, Big McNeil Slough was made into a popular local fishery and recreational area when Oxarart Dam was constructed. This dam washed out in the late 1970's and has never been reconstructed. A series of beaver dams now impound some water, but not enough to support fish, and the beaver dams could not withstand a flood event in the Milk River (per com F. Prellwitz, USFWS 2003).

Rebuilding a dam in the slough and/or in the Milk River could rebuild the old fishery and provide tremendous local recreational potential. It would also have waterfowl benefits for wood ducks and common goldeneyes and possibly some mallards and American wigeons. Bald eagle use of the area might also increase from that which occurs there now (per com F. Prellwitz, USFWS 2003).

5.4 Hewitt Lake National Wildlife Refuge

Hewitt Lake NWR is a 1,680-acre refuge located just west of Nelson Reservoir (see Figure 5.5). About half of the refuge is owned by the FWS. Most of the refuge is covered with Hewitt Lake, which is a large shallow basin that is dry is some years. Like Bowdoin, Hewitt NWR provides habitat for migratory and resident birds and other wildlife, including pronghorn antelope, black-tailed prairie dogs, and mountain plover. The unit is within the Bureau of Land Management's Area of Critical Environmental Concern for the Big Bend of the Milk River, with huge encampment sites and bison kill areas surrounding the refuge. (WILDERNET 2003)(GORP 2003)

Adding a secondary dam to Nelson Reservoir would extend the reservoir westward and northward. If the dam were high enough, water would be backed up to a location that would provide an opportunity to transfer additional water from Nelson over to Hewitt Lake National Wildlife Refuge which currently experiences water-short years on a regular basis (see Figure 5.5). (email from F. Prellwitz, USFWS 2003).

5.5 Milk River

The Milk River is home to many native fish, including Sauger. Pallid Sturgeon and Paddlefish, which live in the Missouri River below Fort Peck Dam, may also be, or potentially be, attracted to the relatively warm and muddy waters of the Milk River.

The Milk River also provides unique terrestrial habitat. The 382-acre northern unit of the Milk River Wildlife Management Area (WMA) is located along the Milk River just east of Nelson Reservoir. This area is designated to provide riparian/wetland habitats for wildlife, particularly waterfowl, and to provide public recreational opportunities, including hunting. The WMA is home to white-tailed deer, upland gamebirds, furbearers, numerous waterfowl, shorebirds, raptors, and a host of songbirds.(FWP 2003)

Diverting water from the Milk River into an enlarged Dodson South Canal or into Nelson Reservoir via a pumping unit would mean that less water would be flowing in the Milk River during times of increased diversion. However, each of the three mitigation projects proposed would allow for greater operational flexibility throughout the Milk River Project and could provide for more stable water deliveries downstream of Nelson Reservoir.

According to the DNRC and FWP, there are no legally defined minimum flows for any stretch of the Milk River.

5.6 Threatened and Endangered Species

Nelson Reservoir, Bowdoin NWR, Hewitt NWR, McNeil Slough, the Milk River, and Dodson South Canal provide a variety of valuable aquatic and terrestrial habitat types. Maintaining a variety of healthy ecosystems in the area is vital to maintaining biodiversity and bounty. Though all fisheries and wildlife in the area are considered valuable, several species that could be or are known to be present in the area are of unique concern due to their listing by the Endangered Species Act (ESA).

Preliminary investigations indicate that the ESA listed species in Table 5.1 could be impacted by the proposed mitigation measures.

Table 5.1 ESA Threatened and Endangered Species that could be impacted by the proposed mitigation measures *

Endangered	Threatened	Candidate
Black-footed Ferret Pallid Sturgeon	Piping Plover Bald Eagle	Blacktail Prairie Dog

*This information is based on preliminary investigations and is not intended to be all-inclusive.

In addition to the species listed in the table, it is possible that other threatened and endangered species, such as grizzly bear and grey wolf, migrate through the area. Additional information on some of these species is provided below.

5.6.1 Piping Plover

In Montana, nesting habitat for the piping plover is primarily unvegetated sand-pebble beaches or islands in freshwater and saline wetlands, and shorelines and exposed beds of larger reservoirs and rivers in the north-central and eastern portions of the state. Piping plover are known to exist at Bowdoin NWR and around Nelson Reservoir. (FWP 2003b)

The FWS has designated Bowdoin NWR as a critical habitat for the Northern Great Plains population of piping plover. Designated areas of critical habitat include prairie alkali wetlands and surrounding shoreline; river channels and associated sandbars and islands; and reservoirs and inland lakes and their sparsely vegetated shorelines, peninsulas, and islands. These areas provide primary courtship, nesting, foraging, sheltering, brood-rearing and dispersal habitat for piping plovers. (FWS 2003b)

A 1995 Memorandum of Understanding (MOU) among US Bureau of Reclamation, US Fish & Wildlife Service, Malta Irrigation District, and Glasgow Irrigation District described the agreed upon management of Nelson Reservoir for the conservation of the Piping Plover. This agreement indicates that the nesting and brood rearing season for the Piping Plover around Nelson Reservoir is approximately May 15 to August 15. As part of this MOU, it is agreed that all attempts will be made to fill Nelson Reservoir to its maximum level by May 15, or until the first plover nest of the season is identified. After that date, the water level must be maintained with no less than 12 inches of vertical freeboard.

5.6.2 Blacktail Prairie Dog

Numerous Blacktail Prairie Dog towns are known to exist around Nelson Reservoir. In addition to being a candidate species, blacktail prairie dogs are considered to be a keystone species because several other species are dependent on the presence of the prairie dogs and their colonies. These species include black-footed ferret (endangered species), burrowing owl, mountain plover (petitioned species), ferruginous hawk, golden eagle, swift fox, horned lark, deer mouse, grasshopper mouse. Other wildlife has also been found to have strong relationship with prairie dogs including many grassland birds. These findings are particularly important for biodiversity, as grassland birds are suffering the sharpest decline of any other group of birds since the early. (FWP 2003b)

The secondary dam has the potential to inundate the Blacktail Prairie Dog towns that are known to exist around the west end of Nelson Reservoir. It is possible to mitigate this impact by raising the water level behind the secondary dam very slowly, allowing time for the prairie dogs to move their homes.

5.6.3 Pallid Sturgeon

The pallid sturgeon is one of the rarest fishes in North America and was listed as endangered in 1990. In Montana pallid sturgeon are presently found in the Missouri River below Fort Peck Dam and from upstream of Fort Peck Reservoir (Nichols Coulee) to Stafford. The pallid sturgeon range in Montana and western North Dakota has declined to 60% of their historical range with recent sightings concentrated in 27% of their range. Most pallid sturgeon have been found near the Missouri/Yellowstone river confluence, the lower 110 km of the Yellowstone River, the tailwaters of Fort Peck dam, and the lower 130 kilometers of Missouri River above Fort Peck Reservoir. (FWP 2003c)

The pallid sturgeon populations in Montana are in danger of going extinct. Dams are assumed responsible for the pallid sturgeon's decline by isolating pallid sturgeon populations, altering flow regimes, and reducing habitat. Fort Peck Dam has caused dramatic changes in flow, temperature, and turbidity in the Missouri River; however these changes are sometimes tempered during high run-off period of the warm and turbid Milk River which enters the Missouri River 16 km downstream Fort Peck dam. (FWP 2003c)

5.7 Species of Special Concern

In addition to those species protected by the ESA, there are several Montana Species of Special Concern that could be or are known to be present in the area. Among the listed fish species are the native Sauger and Paddlefish, which are described in more detail below.

5.7.1 Sauger

Sauger, a native fish of Montana, remains common in only about 25% of their historic range. Surveys in the 1990's indicate population declines of 75% to 90% in the sauger population present in the middle Missouri River and in Fort Peck Reservoir. Severe declines in sauger populations appear to have been caused by the droughts of the late 1980's which limited spawning, and dried up shallow water areas that are important to young fish. In addition, dams block important sauger migration corridors and drastically alter river habitat. (Walleyes Unlimited 2003)

5.7.2 Paddlefish

Paddlefish, another native of Montana, are older than dinosaurs. The only places on earth they survive are in the Yangtze River in China and in the Missouri/Mississippi River systems in the U.S.A. Paddlefish numbers have been greatly reduced in large portions of their historic range, especially in the Mississippi and its upper tributaries. In Montana, paddlefish are known to exist in the Missouri River below Fort Peck Dam and may swim upstream in search of gravel beds for spawning in the spring. (MRA 2003)

The paddlefish is currently being reviewed by FWS for official listing as an endangered or threatened species. (USGS 2003)

The proposed mitigation measures have the potential to impact fisheries in the Milk River by reducing flows, altering flow regimes, creating backwaters, blocking passage, and/or entrainment. However, it is also possible that the management flexibility provided by the mitigation measures could also be used to enhance fisheries.

5.8 Permitting and Compliance

5.8.1 NEPA Process

All three of the proposed mitigation measures would be within the Milk River Project and as such be considered to be a federal undertaking and would require compliance with the National Environmental Policy Act (NEPA). All three measures would also have the potential to impact threatened or endangered species (see Section 5.6) which would trigger the need for completing an Environmental Assessment (EA) and potentially a more extensive Environmental Impact Statement (EIS). A thorough environmental investigation would be required even if the proposed actions are intended to benefit selected habitat or species.

It would be most logical to conduct the NEPA process on all three proposed measures together, even if only one is selected for construction, because NEPA requires analysis of cumulative impacts. In addition, the impact of each project will depend on whether or not the other projects are constructed and how they would be operated. If the proposed mitigation measures might be constructed in conjunction with other Milk River Projects (Fresno Dam expansion, for example) then those measures should also be included into single comprehensive evaluation. NEPA compliance could cost anywhere from $10,000 to $50,000 or more for the three projects.

5.8.2 404 Permits

Section 404 of the Clean Water Act prohibits discharging dredged or fill material into U.S. waters without a permit from the U.S. Army Corps of Engineers. "U.S. waters." includes all tidal waters, all interstate waters, virtually all wetlands, lakes, rivers, perennial and intermittent streams, and dry washes in the arid west. To grant a permit, the Corps must weigh the need to protect aquatic resources against the benefits of the proposed development. Corps policy requires applicants to avoid impacts to wetlands and other U. S. waters to the extent practicable, then minimize the remaining impacts, and finally take measures to compensate for unavoidable impacts. (USACE 2003)

All three of the proposed mitigation measures include construction and/or disturbance within U.S waters and would likely require compliance with Section 404 of the Clean Water Act.

5.8.3 Other

All water projects constructed by the USBR require coordination with the US Fish &Wildlife Service (FWS) as per the Fish & Wildlife Coordination Act. This act requires that the FWS conduct a Section 3.B.1 Study for the USBR and offer alternatives to and/or mitigation measures for the proposed project. Incorporating these measures into a project could avoid entering the full NEPA EIS process.

If any of the proposed projects is considered to be a federal undertaking, they may be required to comply with Section 106 of the National Historic Preservation Act.

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FIGURES

Figure 1.1 Map of Milk River Project

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Figure 1.2 Map of Dodson Diversion Dam and Dodson South Canal

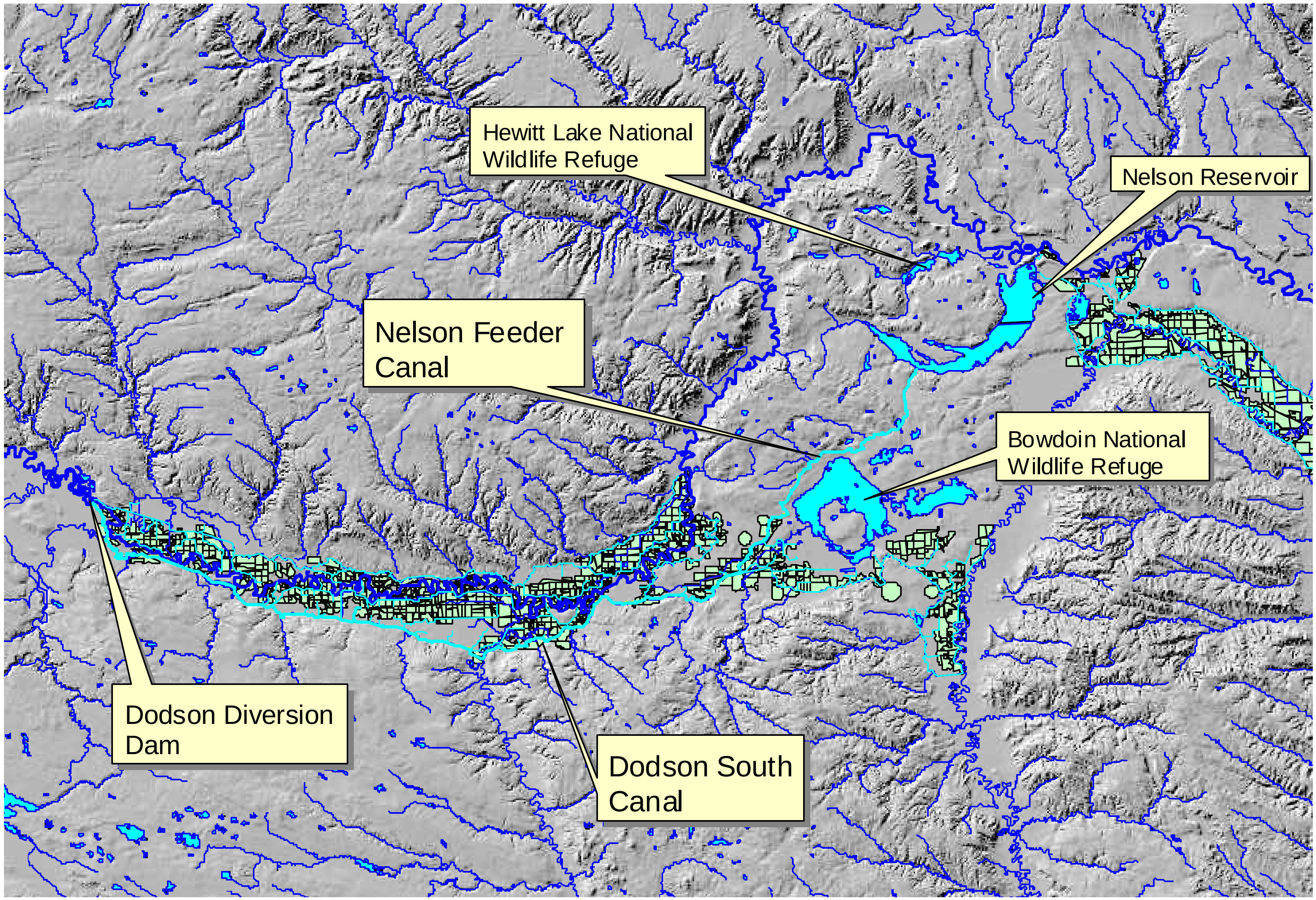

Figure 1.3 Map of Nelson Reservoir –Plan of Development

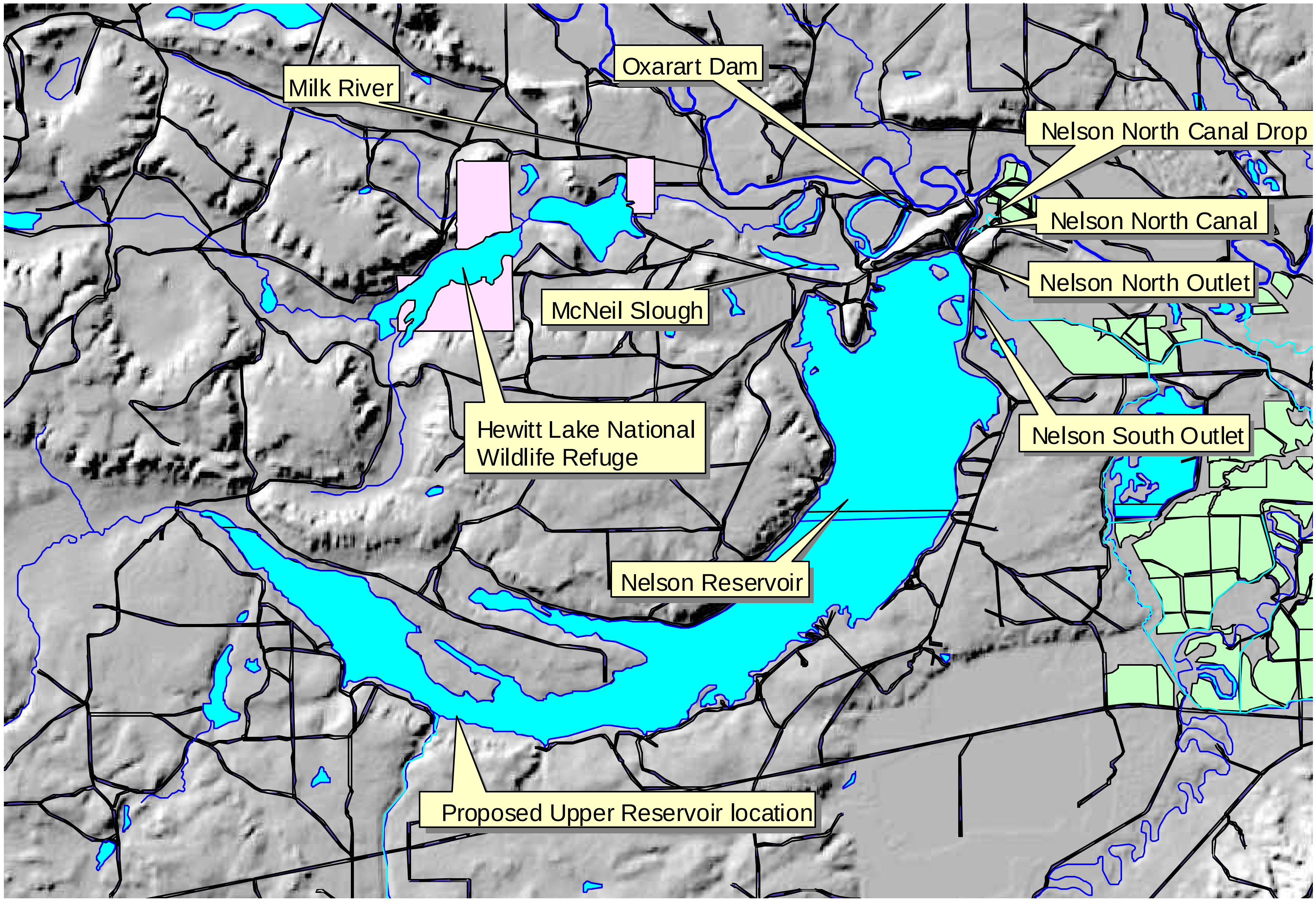

Figure 2.1a Nelson Reservoir Pump Lift – Nelson North Outlet Canal, North Outlet Works Unit: Alternative in Existing Well

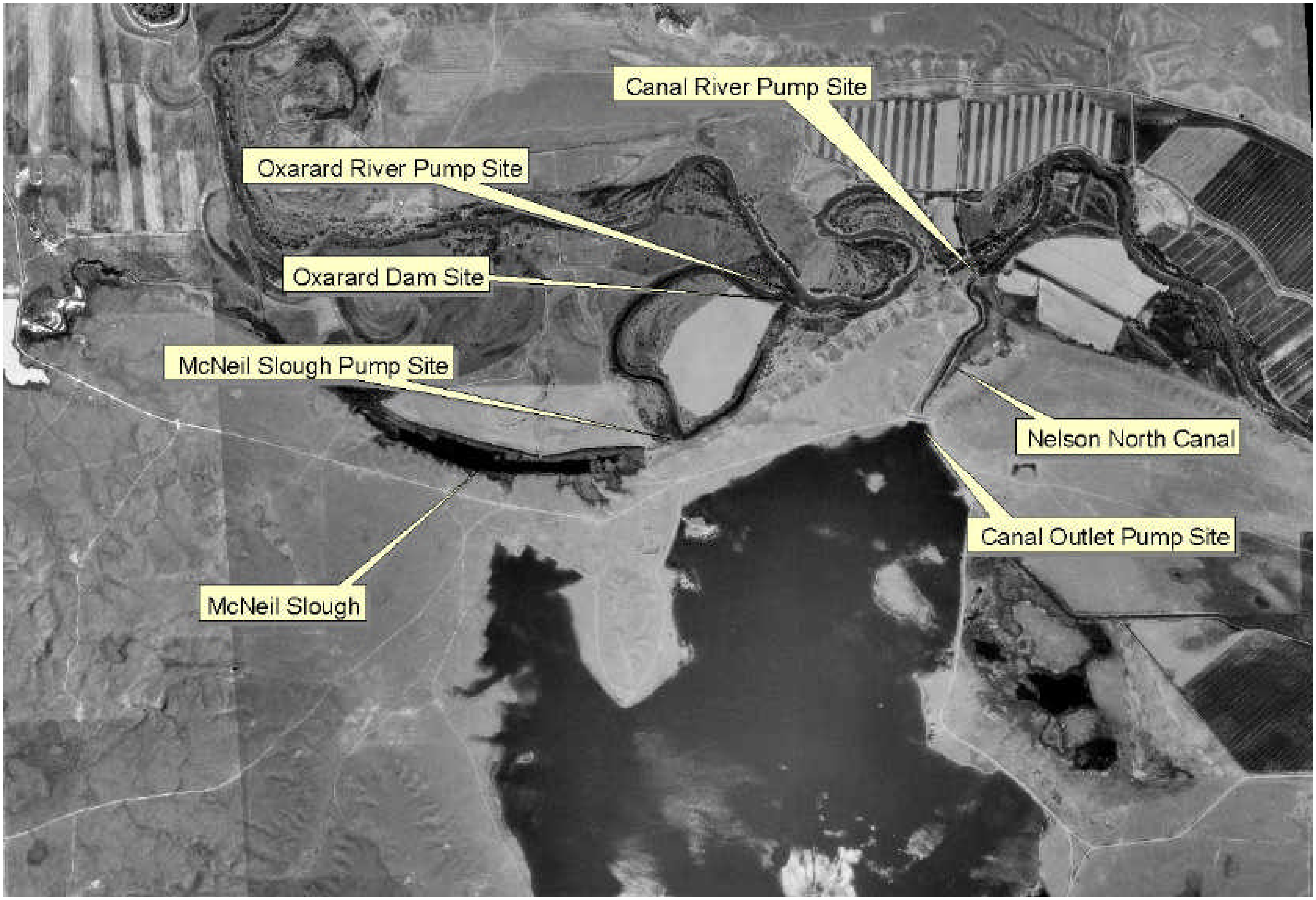

Figure 2.1 Nelson Reservoir Pump Lift – Nelson North Outlet Canal, North Outlet Works Unit: Alternative in Existing Well

11x17 map insert

Figure 2.2 Nelson Reservoir Pump Lift - Nelson North Outlet Canal, North Outlet Works Unit: Alternative below Outlet Works

11x17 map insert

Figure 2.3 Nelson Reservoir Pump Lift - Nelson North Outlet Canal, Milk River Unit: Sump and Vertical Turbine Pump

11x17 map insert

Figure 2.4 Nelson Reservoir Pump Lift – Nelson North Outlet Canal, Milk River Unit: Modifications to Canal Drop Structure

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Figure 2.5 Nelson Reservoir Pump Lift - Nelson Outlet Canal Milk River Unit: Example of a Floating Pump Station

Figure 3.1 Site Map of Proposed Dodson South Canal Rehabilitation Project

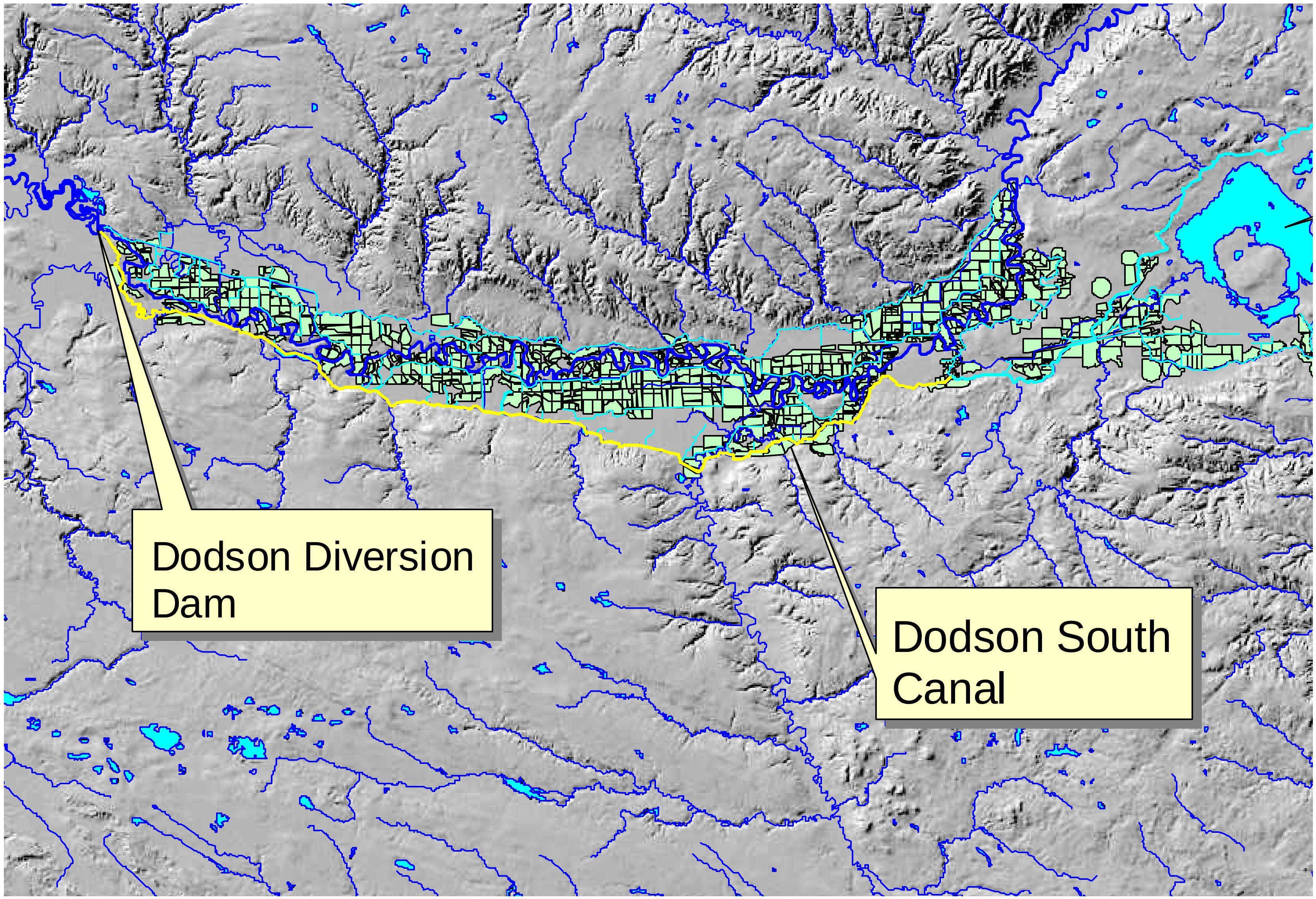

Figure 4.1 Nelson Reservoir Secondary Dam – Plan View

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Figure 4.2 Nelson Reservoir Secondary Dams – Maximum X-sections

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Figure 4.3 Nelson Reservoir Secondary Dams – Outlet Works

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Figure 5.1 Map of Nelson Reservoir

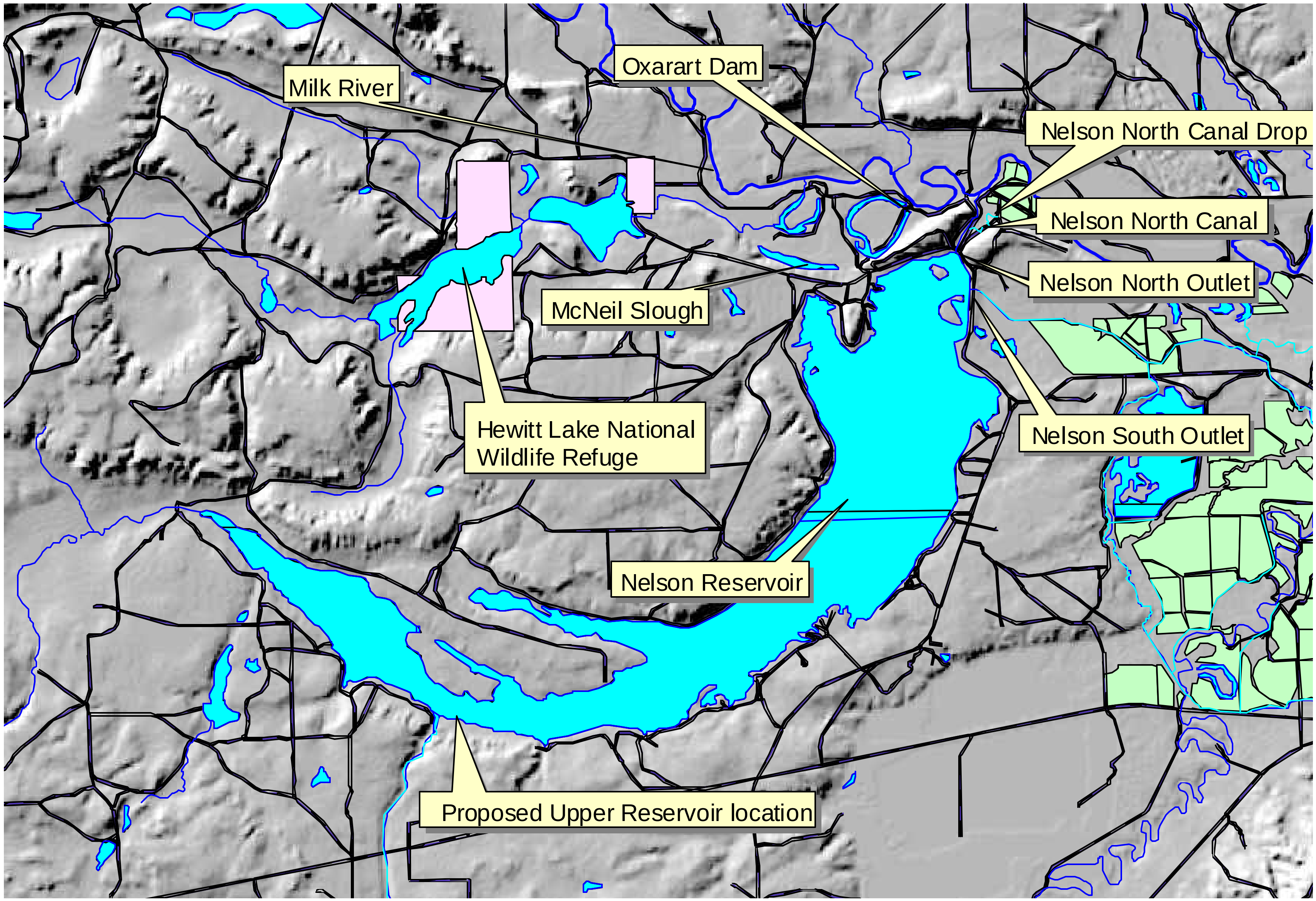


Figure 5.2 Nelson Reservoir Water Levels from 1987 – 2002

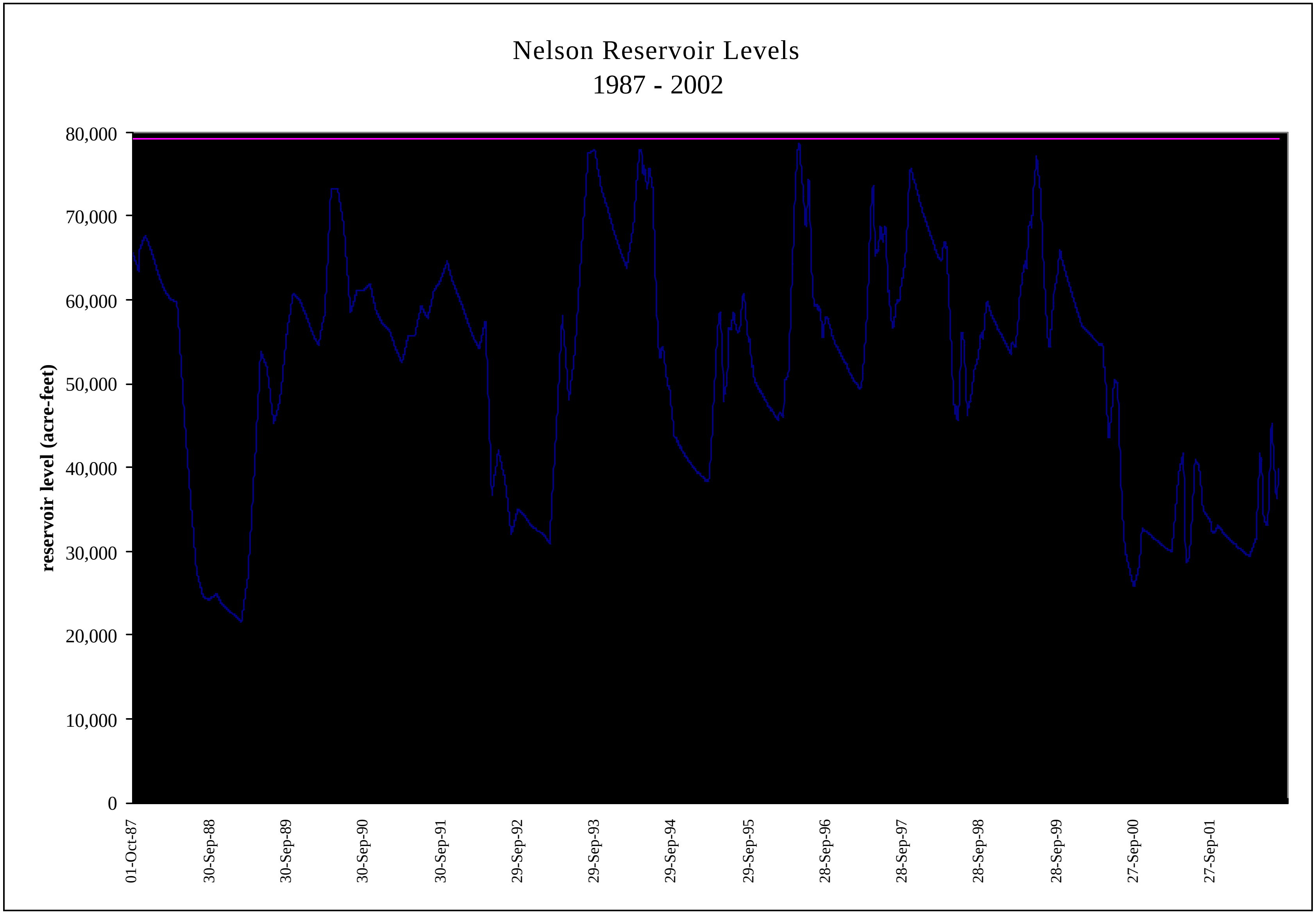


Figure 5.3 Map of Bowdoin National Wildlife Refuge

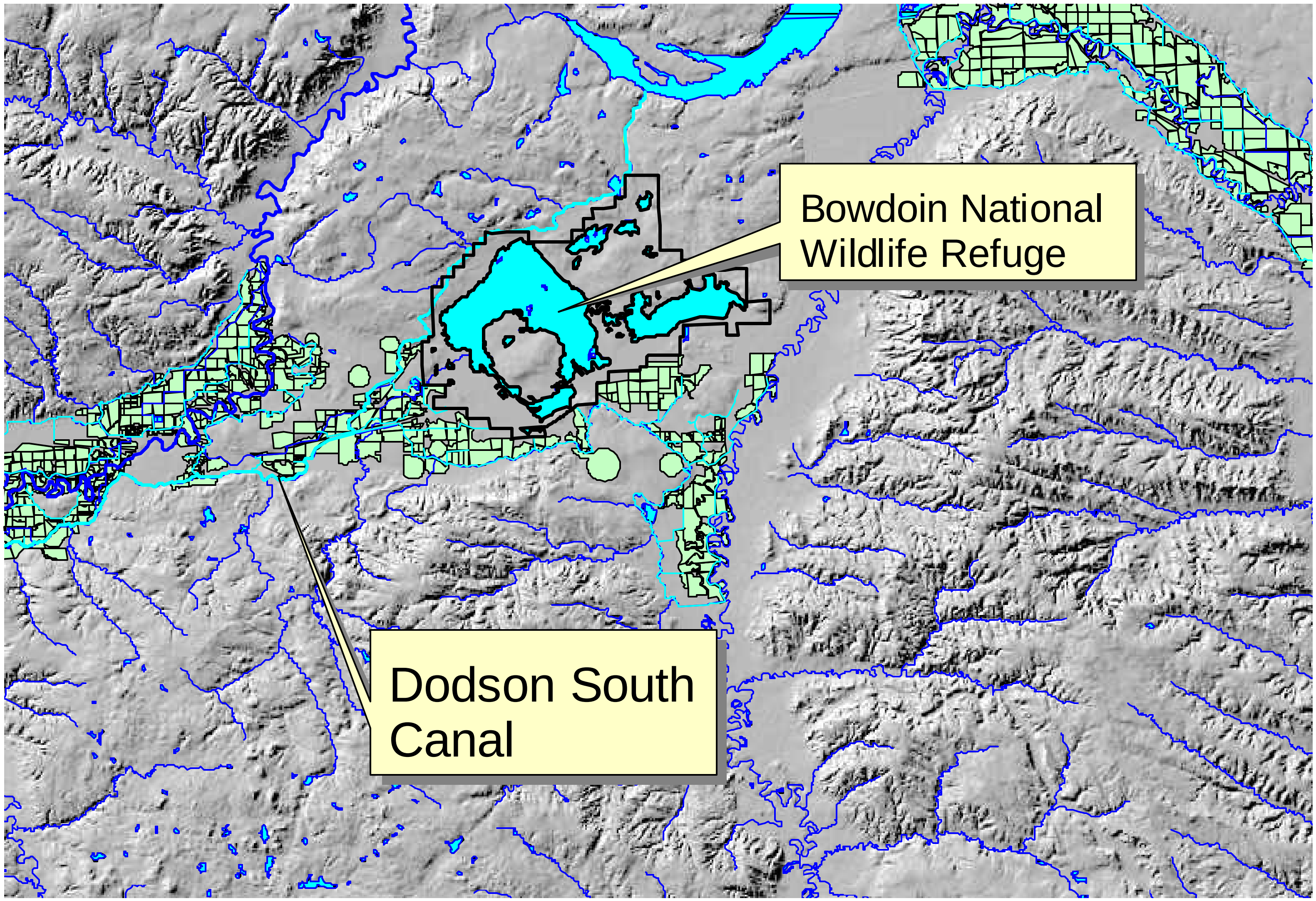


Figure 5.4 Map of Big McNeil Slough

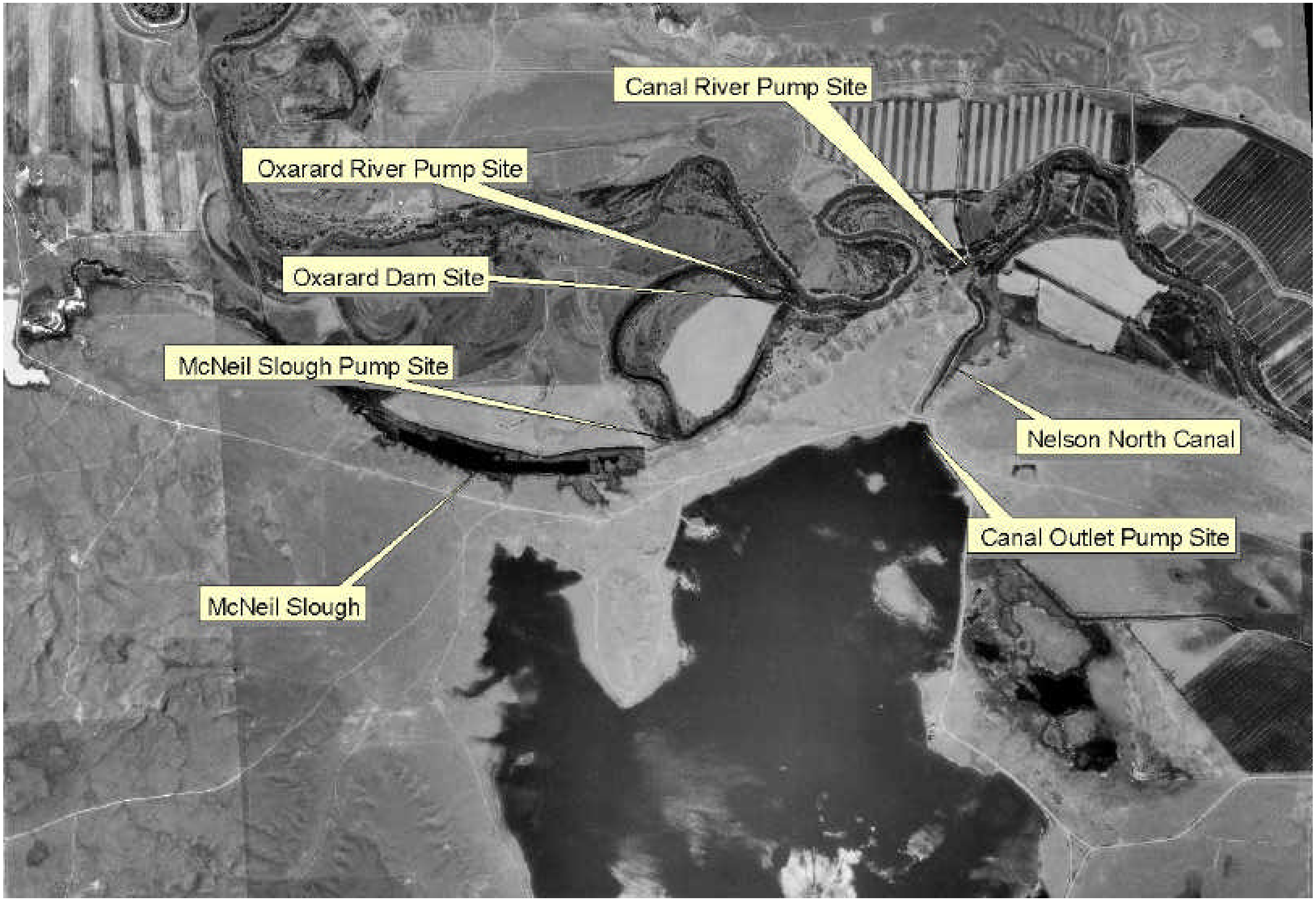
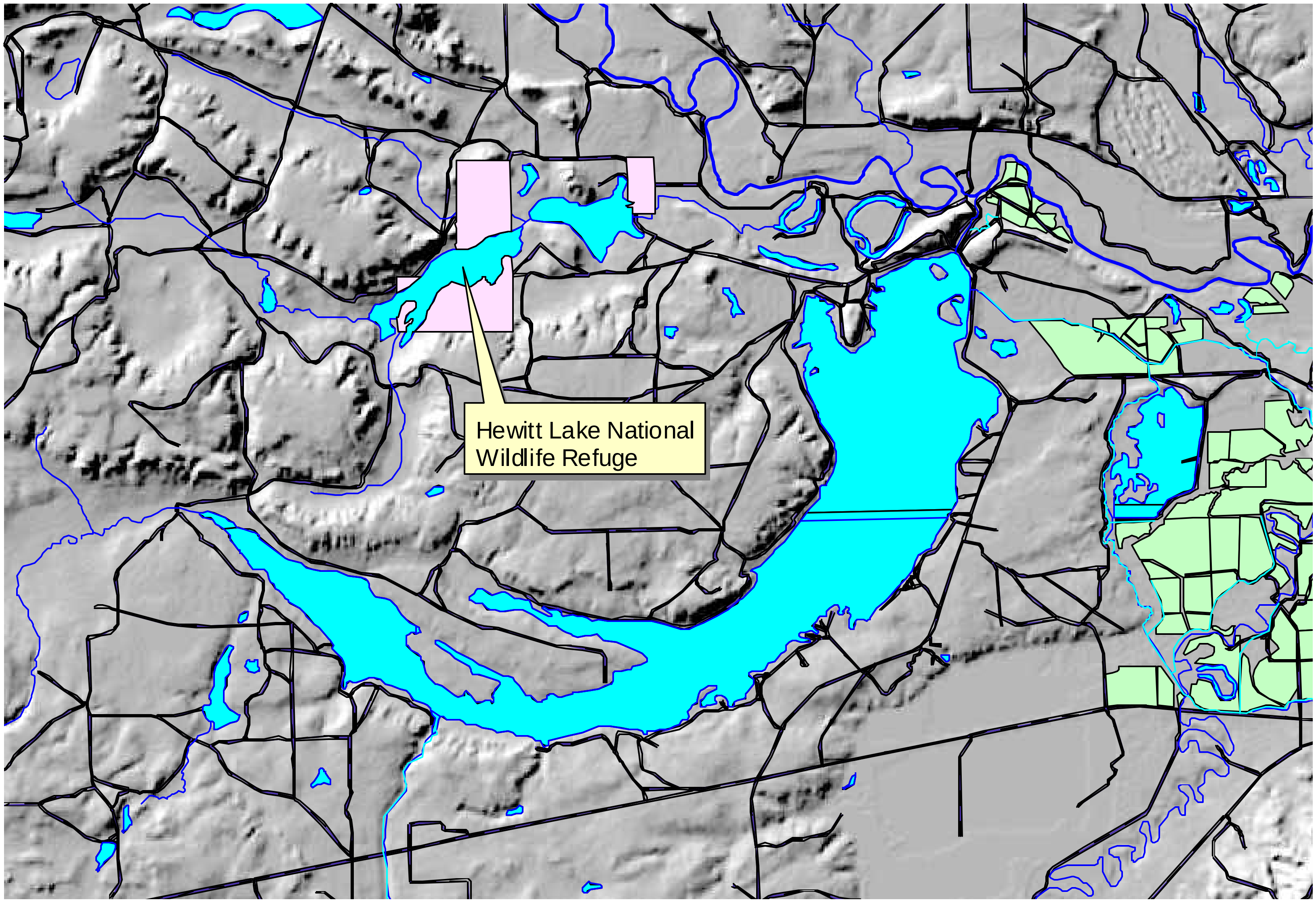


Figure 5.5 Map of Hewitt Lake National Wildlife Refuge



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PHOTOS

Photo 1 Upstream (reservoir) side of the North Outlet Works of Nelson Reservoir, looking southeast at the reservoir.

Photo 2 Downstream (canal) side of the North Outlet Works of Nelson Reservoir.

Photo 3 Upstream side of the Canal Drop Structure in Nelson North Outlet Canal near the Milk River.

Photo 4 Confluence of the Nelson North Outlet Canal and the Milk River, as viewed downstream of Canal Drop Structure.

Photo 5 Upstream side of the Cree Crossing Bridge over the Milk River (proposed site for floating pump unit).

Photo 6 Example of a floating pump unit

Photo 7 Confluence of Dodson South Canal and Nelson Reservoir, looking north at the reservoir (proposed secondary dam site is on the right side of the photo, east of the confluence).

Photo 8 Dodson South Canal, looking upstream from site where the canal discharges in to Nelson Reservoir (note erosion).

Photo 1 Upstream (reservoir) side of the North Outlet Works of Nelson Reservoir, looking southeast at the reservoir.

Photo 2 Downstream (canal) side of the North Outlet Works of Nelson Reservoir.

Photo 3 Upstream side of Drop Structure in Nelson North Outlet Canal near the Milk River.

Photo 4 Confluence of the Nelson North Outlet Canal and the Milk River, as viewed downstream of Canal Drop Structure.

Photo 5 Upstream side of the Cree Crossing Bridge over the Milk River (proposed site for floating suction unit).

Photo 6 Example of Floating Suction Pump System (See Ames Manufacturing website).

Photo 7 Confluence of Dodson South Canal and Nelson Reservoir, looking north at the reservoir (proposed secondary dam site is on the right side of the photo, east of the confluence).

Photo 8 Dodson South Canal, looking upstream from site where the canal discharges in the Nelson Reservoir (Note erosion).

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APPENDICES

A. Description of the Lower Milk River Model (BOWDOINAVAIL.XLS)

B. Hydraulic Analyses of Nelson North Outlet Canal

C. Hydraulic Analyses of Dodson South Canal

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APPENDIX A

DESCRIPTION OF LOWER MILK RIVER MODEL (BOWDOINAVAIL.XLS)

APPENDIX A

Description of Lower Milk River Model (BOWDOINAVAIL.XLS)

A.1 Background

The RWRCC has developed a spreadsheet model (BOWDOINAVAIL.XLS) to help evaluate the hydrologic impacts of three measures proposed by RWRCC to mitigate the impacts of the Fort Belknap compact. The three mitigation measures modeled are: (1) Installing a pumping unit at Nelson Reservoir, (2) Enlarging the Dodson South Canal, and (3) Installing a secondary dam at the upper end of Nelson Reservoir. The first two measures would involve diverting additional water out of the Milk River for storage in Nelson Reservoir and later release for downstream irrigators.

The proposed mitigation measures are designed to provide more water, or a more stable water supply, to irrigators and other water users that could be adversely impacted by the development of the Fort Belknap water rights. The model is designed to determine if historical flows or minimum flows in the Milk River below Nelson Reservoir (represented by the Juneberg Bridge and Tampico gages) could be maintained with the mitigation measures in place.

A.2 Model Description

The spreadsheet contains 14 years (1987 – 2002) of historical daily flow data from gages located on the Milk River below Dodson Diversion Dam, at Juneburg Bridge, and at Tampico, as well as recorded water levels in Nelson Reservoir. These daily flows, along with the input parameters described below, are used in equations (in the form of "if-then" statements) designed to represent water management decisions that could be made if the three mitigation measures were implemented. The results of these decision-making equations are 14 years of calculated daily values for additional water diversions into Dodson South Canal, changes in inflow/outflow and storage in Nelson Reservoir, and additional diversions to Bowdoin National Wildlife Refuge. The model runs were performed in June 2002.

A.3 Model Assumptions

The decision-making equations in the model are based on the assumption listed below. Some of these assumptions can be adjusted based on the selection of input parameter values.

<u>A.3.1 Dodson South Canal</u>

? All additional water diverted into Dodson South Canal is delivered to Bowdoin and/or Nelson Reservoir. This assumption is based on the idea that any increase in evaporative and seepage losses caused by an increase in canal flow will be minimal. It does not reflect the possibility that an increase in canal flow will be diverted by water users along the canal.

? Additional diversions into Dodson South Canal can only occur between selected dates (March 30 to November 3 for example).

- ? Additional water can be diverted into Dodson South Canal only if the selected minimum flows in the river below the diversion dam are met. Additional diversions are also limited to the selected additional capacity of the canal.
- ? Additional water can be diverted into Dodson South Canal only if a selected minimum amount of water is physically available in the Milk River.

A.3.2 Bowdoin National Wildlife Refuge

- ? A portion of the additional water diverted into the Dodson South Canal will be diverted into Bowdoin National Wildlife Refuge. The portion sent to Bowdoin is based on water levels in Nelson Reservoir. When Nelson Reservoir is at or above a target level, increasing portions of the additional water in the canal would be sent to Bowdoin until the reservoir is full, at which point 100% of the additional water would be sent to Bowdoin.
- ? Water currently diverted into Bowdoin National Wildlife Refuge is no longer available to other users in the basin.

A.3.3 Nelson Reservoir

- ? Water diverted into Dodson South Canal is not available for the Nelson Pumping Unit.
- ? The Nelson pumping unit can only operate between selected dates (March 1 to November 30 for example).
- ? The amount of water pumped into Nelson Reservoir is limited to the capacity of the pumps.
- ? Water can be pumped into Nelson Reservoir only if the selected minimum flows in the river below the reservoir are met. The model accounts for the time it takes for water to flow from the pumping unit to the downstream gaging stations.

A.4 Model Input Parameters

The model allows the selection of several parameters which affect the water management decisions options. These parameters are listed and described below.

Dodson Diversion - minimum river flow

The minimum flow that must remain in the Milk River below Dodson Diversion Dam after additional water is diverted into the enlarged canal, measured in cfs. If river flow at this gage is at or below this level, additional diversions into the canal cannot occur. “Additional water” in the Dodson South Canal refers to the amount of water, in addition to historical levels, that could be diverted into the canal if it were enlarged.

Dodson Diversion - minimum canal flow

The minimum amount of water that must be physically available in the Milk River before any additional diversions can be made into Dodson South Canal, measured in cfs.

Dodson Diversion – increase canal flow

The maximum increase in canal capacity that will be generated from enlarging the canal, measured in cfs. This represents the limit of additional water that may be diverted into the canal from the Milk River.

Dodson Diversion Canal – start month and day
The first month and day in the year that additional diversions into the canal can occur.

Dodson Diversion Canal – end month and day
The last month and day in the year that additional diversions into the canal can occur.

Maximum Nelson Level
The maximum storage capacity of Nelson Reservoir, measured in acre-feet.

Nelson Reservoir Target Level
The level of the reservoir, considered close to full, above which triggers a portion of the additional water from Dodson South Canal to be diverted into Bowdoin NWR rather than Nelson Reservoir.

Nelson Pump Lift – Minimum MR flow
The minimum flow that must remain in the Milk River after water is removed from the river by the Nelson Pump Lift, measured in cfs.

Nelson Pump Lift – Nelson Pump Cap
The capacity of the pumps at the Nelson Pumping Unit, measured in cfs.

Nelson Pumping – start month and day
The first month and day in the year that pumping into the reservoir can occur.

Nelson Pumping – end month and day
The last month and day in the year that pumping into the reservoir can occur.

A.5 Sample Input Page

The blocks highlighted in yellow are input parameters.

bowdoinavail.xls

Inputs and Summary of Results

Dodson diversion canal		**Nelson pumping**	
3	start month	3	start month
30	start day	1	start day
3.94		3.03	
11	end month	11	end month
3	end day	30	end day
11.09		11.94	

(cfs)	**Dodson Diversion Dam**				
25	Min river flow	25	25	25	25
50	Min canal flow	50	50	50	50
100	Increase canal flow	100	100	100	100
(ac-ft)					
75000	Max Nelson level	75000	75000	75000	75000
(cfs)	**Nelson Pump Lift**				
10	Min MR flow	10	10	10	10
50	Nelson pump cap	0	5	25	50
(ac-ft)	**Diversion into Bowdoin NWR**				
60000	Nelson Res. target level	60000	60000	60000	60000
1000 af	**Average Annual Flows over the 14-year modeling period**				
14.979	increase in canal flows	14.979	14.979	14.979	14.979
11.373	water pumped at Nelson	0.000	1.687	6.991	11.373
11.317	water avail for Bowdoin from Dodson	8.142	8.634	10.240	11.317
3.662	water avail for Nelson from Dodson	6.837	6.345	4.739	3.662
26.352	increased canal + water pumped	14.979	16.666	21.970	26.352
15.036	total increase at Nelson	6.837	8.033	11.731	15.036

A.6 Sample Calculation Worksheet

A small portion of the calculation worksheet is shown below. The columns highlighted in orange are calculated results. (Please note that the columns have been compressed to fit on this page.)

	flow evaluator	Gaged Milk River flows below Dodson diversion	Availabe flow at Dodson diversion dam	Increased Dodson canal diversions	Calculated Nelson Res inflow w/ outflow	Recode Nelson Res levels af-ft	Modified Nelson Res levels af-ft	Nelson pump evaluator	Avail flow at Nelson pump	Nelson pumping	Nelson pumping (af)	Gaged Milk River flows at Juneburg bridge	Gaged Milk River flows at Tampico	Flow available for Bowdoin
01-Oct-87	1	5	5	5		65665	65665	1		0	0	0	0	2
02-Oct-87	1	4	4	4	-38	65589	65593	1	0	0	0	0	0	1
03-Oct-87	1	6	6	0	-38	65513	65515	1	0	0	0	0	0	0
04-Oct-87	1	6	6	0	-38	65437	65439	1	16	0	0	0	0	0
05-Oct-87	1	6	6	0	-38	65361	65363	1	15	0	0	0	0	0
06-Oct-87	1	5	5	0	-38	65286	65287	1	10	0	0	0	0	0
07-Oct-87	1	5	5	0	-38	65210	65211	1	10	0	0	0	0	0
08-Oct-87	1	6	6	0	-38	65134	65135	1	10	0	0	0	0	0
09-Oct-87	1	8	8	0	-38	65058	65059	1	10	0	0	0	0	0
10-Oct-87	1	7	7	0	-38	64982	64983	1	89	50	99	99	380	0
11-Oct-87	1	7	7	0	-38	64906	65006	1	15	15	30	102	395	0
12-Oct-87	1	9	9	0	-38	64830	64960	1	8	8	16	102	380	0
13-Oct-87	1	11	11	0	-38	64754	64900	1	9	9	18	99	125	0
14-Oct-87	1	16	16	0	-38	64678	64842	1	12	12	24	95	25	0
15-Oct-87	1	18	18	0	-38	64602	64790	1	13	13	26	94	18	0
16-Oct-87	1	17	17	0	-38	64527	64740	1	14	14	28	95	19	0

A.7 Comments on the Model

Below is a list of comments to keep in mind when using the model and/or interpreting model results.

? As with all models, it is important to understand what this model is designed to do. In this case, the model is to be used as a tool to provide numbers to help answer the question "What would have happened to daily flows and reservoir levels over the past 14 years (1987 - 2002) if the three proposed mitigation measures were in place and operated under different management scenarios?" It is equally important to understand what the model is not designed to do.

? Selecting different water management scenarios is accomplished through the selection of input parameters. However, it is not clear to the uninformed user what these decisions are or how the input parameters affect these decisions.

? The results of the management decisions are reflected in calculated additional diversions to Dodson South Canal; modified Nelson Reservoir levels, inflows, and outflows; water pumped into Nelson Reservoir; and flows available for Bowdoin National Wildlife refuge. The model does not calculate the modified Milk River flows below Dodson Dam or Nelson Reservoir, the amount of water that would be stored behind the secondary dam, or the amount of water that would be available to downstream water users (those that rely on releases from Nelson Reservoir). Without these results, it is not clear whether the measures are accomplishing the desired mitigation and what the impacts to Milk River flows would be. It does, however, calculate the amount of water that would reach Bowdoin, which is one of the desired mitigation measures.

? There is some concern that travel times for water are not accurately represented.

? The model assumes that all additional water diverted into Dodson South Canal would be delivered to Bowdoin or Nelson Reservoir; however, it is commonly thought is that only a portion or even none of this water would make it that far due to illegal and unmonitored withdrawals along the way.

? The model does not determine how much water that enters Nelson Reservoir from Dodson South Canal would or could be stored behind the secondary dam. The model also does not allow the reservoir to be managed to accommodate the MOU that requires reservoir levels to remain at or below May 15th levels during piping plover nesting season.

? The model does not incorporate the Tribes' use of water.

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APPENDIX B

HYDRAULIC ANALYSIS OF NELSON NORTH OUTLET CANAL

APPENDIX B

Hydraulic Analysis of Nelson North Outlet Canal

Hydraulic Analysis
Reverse Flow Nelson North Outlet Canal

B.1 Introduction

The north outlet canal and surrounding area was surveyed by Aquoneering on January 8, 2003. The survey consisted of several cross sections. The first cross section, Cross Section 1.1, is located immediately downstream from the concrete drop structure at the dam. The remaining cross sections, Cross Sections 1.2, 1.3, 1.4, 1.5, 1.6, 1.7 1.8, and 1.9 were placed at various distances downstream form Cross Section 1. Cross Section 1.9 was placed immediately upstream of the Milk River drop structure.

B.2 Analysis

The outlet canal normally conveys water from the reservoir to the Milk River. Aquoneering proposes to reverse this flow of the slough to achieve a flow of 50 CFS from the river to the proposed pumping station at the outlet of the Nelson Dam. A water surface elevation of 2207.75 ft at the dam drop structure must also be achieved to allow for the proposed pump station operation at the dam.

This report analyzes the hydraulics of Nelson North outlet canal with a reverse flow of 50 CFS. The analysis will be performed using the computer-modeling program HEC-RAS by BOSS Int.

Survey data, used to generate the HEC-RAS model, was directly imputed in to the HEC-RAS though a computer program AutoCAD for BOSS RMS.

Flow data, which was imputed into the HEC-RAS model, included the following parameters:

? A flow rate of 50.0 CFS,
? Manning friction factors of 0.025 for the slough channel and 0.035 for the over bank area, and
? An Expansion and Contraction coefficient of 0.3 and 0.1.

B.3 Results

The results of the hydraulic analysis indicated that 50 CFS could be reversed though the canal. However, the resulting water surface elevation at Cross Section 1.1 is below the 2207.75 ft elevation required to operate the pumps.

The model of McNeal Slough was modified by adding a “dummy” cross section, Cross Section 1, upstream of Cross Section 1.1. The cross section was constructed using Cross Section 1.1 as a template. The channel bottom of the newly constructed cross section was modified to model a weir by raising the bottom elevation of the channel at Cross Section 1 above the elevation of the bottom channel at Cross Section 1.1. The resulting cross section would form a trapezoidal weir with a flat bottom.

To determine the required weir elevation, the bottom elevation of the Cross Section 1 was modified and raised to different elevations until resulting water surface elevation at Cross Section 1 was near 2207.75 ft. The analysis indicated that a weir elevation of 2207.35 ft at Cross Section 1 will raise the water surface at Cross Section 1 to 2207.75 ft elevation. The resulting water surfaces at the remaining cross section are shown in the following table:

TABLE B1

Cross Section #	Water Surface Elevation @ 50 CFS (Ff)
1	2,207.75
1.1	2207.97
1.2	2207.98
1.3	2207.98
1.4	2207.98
1.5	2207.98
1.6	2207.98
1.7	2207.98
1.8	2207.98
1.9	2207.98

B.4 Discussion

B.4.1 Freeboard

Aquoneering proposes that fill should be added to the banks of outlet canal to provide 1.5 ft of freeboard above the expected water surface of 50 CFS in the canal. The following table summarizes the existing freeboard at given cross sections:

TABLE B2

Cross Section	Left Bank Freeboard (Ft)	Right Bank Freeboard (FT)
1.1	7.13	6.99
1.2	6.06	6.64
1.3	0.44	1.22
1.4	1.55	0.32
1.5	1.31	1.31
1.6	3.34	3.01
1.7	0.53	0.95
1.8	1.96	1.32
1.9	1.74	1.77

The attached spreadsheet "Fill Required for 1.5 Ft of Freeboard" estimates that the total volume of fill required to maintain 1.5 ft of freeboard for the left and right bank of the slough is equal to 826.56 CY.

B.5 Conclusion

The outlet canal has the capacity to transport 50 CFS from the river to proposed pumping station at the Nelson Dam. The slough will require 826 CY of fill to maintain 1.5 ft of freeboard between the top of the banks and hydraulic water surface in the canal.

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APPENDIX C

HYDRAULIC ANALYSIS OF DODSON SOUTH CANAL

APPENDIX C

Hydraulic Analysis of Dodson South Canal

C.1 Introduction

Aquoneering surveyed a representative section of the Dodson South Canal on January 09, 2003. The survey consisted of 15 cross sections. Cross sections were surveyed perpendicular to the flow of the canal. Only one mile, out of over 30 to be cleaned, were surveyed.

Jerry Moore from the United States Bureau of Reclamation was contacted on February 5, 2003. Moore's research into the history of the canal resulted in the discovery of following original design parameters for the canal.

? Hydraulic area = 259.8 CF
? Channel Velocity = 1.91 FPS
? Channel Slope = 0.00014 Ft/Ft
? Design Flow = 496 CFS
? Side Slopes = 1.5 : 1 H:V
? Bottom Width = 40 ft
? Design Depth = 5.4 ft

The slope of the canal was supported by examination of the 3.5 minute Quad maps of the area.

C.2 Analysis

The hydraulics of the existing canal were analyzed using the computer modeling program HEC-RAS 3.0 by BOSS INT.

Cross Section data was imputed into the computer model manually. Cross sections stations were entered into the program from left bank to right bank facing downstream. Cross Sections were numbered in increasing order moving upstream. Cross Section 9 was found to have incomplete data and was not imputed into the program.

The geometry of the check structure was imputed into the program using HEC-RAS' inline weir option. The weir was analyzed having three gates for a total hydraulic width of 21 ft. The check structure was analyzed assuming all gates were completely open.

A manning friction factor of 0.025 was used for the existing canal channel. A friction factor of 0.035 was used for the overbank areas, typically grassed.

The original design slope of 0.00014 ft/ft was used as the normal depth for the boundary condition option within the flow data menu.

The maximum flow capacity in the channel was determined by running the model at different flows. The flow in the canal was determined to be at maximum capacity when the water surface in all the cross section was a minimum of 2 ft below the top of the left bank

C.3 Results

The resulting analysis indicated that the existing canal has a maximum flow capacity of 450 CFS with a minimum freeboard of 2 ft for all cross sections. The critical cross section, the cross section with the smallest freeboard, was determined to be Cross Section 14. The following table summaries the resulting of the analysis as determined by the model:

Table C1

Cross Section #	Top of Left Bank Elevation (Ft)	Water Surface Elevation @ 450 CFS (FT)	Freeboard (FT)	Channel Velocity (FPS)
1	2313.97	2310.23	3.74	1.82
2	2316.49	2310.27	6.22	1.84
3	2313.72	2310.32	3.40	1.76
4	2313.06	2310.37	2.69	1.64
5	2315.89	2310.41	5.48	1.69
6	2318.39	2310.45	7.94	2.20
7	2318.42	2310.54	7.88	2.26
8	2316.12	2310.59	5.53	1.88
10	2313.85	2310.72	3.13	1.74
11	2313.09	2310.76	2.33	1.80
12	2313.27	2310.76	2.51	2.19
13	2313.56	2310.79	2.77	2.31
14	2312.83	2310.82	2.01	2.46
15	2313.47	2310.86	2.61	2.40

C.4 Discussion

An observation of the canal profile indicates that the canal has a very irregular channel bottom. The channel bottom no longer reflects the original design slope of 0.00014 ft/ft.

Field observation and survey observation of the cross sections indicate that the channel cross sections have accumulated sediment, which has changed the original hydraulics of the canal.

C.5 Channel Cleaning/ Regrading

One way to increase the flow capacity of the canal is to clean and regrade the canal bottom. Cleaning involves excavating the extra accumulated sediment within the canal. The resulting canal should have a trapezoidal cross section with a minimum base width of 40 ft to reflect the original design. Regarding the canal would involve grading the canal bottom so the resulting canal would be at a slope near the original design canal slope of 0.00014 ft/ft.

The cross section data for the existing canal, which was imputed into the HEC-RAS, was modified to reflect a cleaned and graded channel. The resulting channel has a minimum channel base of 40 ft and was graded to a slope of 0.00014 ft/ft. The friction factor for the main channel was reduced from 0.025 to 0.0225.

The modified HEC-RAS model was run at different flows to determine the maximum capacity of the canal assuming a minimum of 2 ft of freeboard at all cross section. The resulting analysis indicated that the modified canal has a maximum flow capacity of 575 CFS with a minimum freeboard at Cross Section 14 of 2.00 Ft. The following table summaries the resulting of the analysis as determined by the new model:

Table C2

Cross Section #	Top of Left Bank Elevation (Ft)	Water Surface Elevation @ 575 CFS (FT)	Freeboard (FT)	Channel Velocity (FPS)
1	2313.97	2310.27	3.70	2.13
2	2316.49	2310.31	6.18	2.13
3	2313.72	2310.37	3.31	1.85
4	2313.06	2310.41	2.65	1.84
5	2315.89	2310.44	5.45	1.87
6	2318.39	2310.47	7.92	2.36
7	2318.42	2310.54	7.88	2.41
8	2316.12	2310.60	5.52	2.06
10	2313.85	2310.70	3.15	2.05
11	2313.09	2310.79	2.30	2.29
12	2313.27	2310.80	2.47	2.36
13	2313.56	2310.82	2.74	2.27
14	2312.83	2310.83	2.00	2.48
15	2313.47	2310.86	2.61	2.49

The increase flow in the clean/regraded canal does have some effect on the stability of the canal. The clean/regraded canal at maximum capacity of 575 CFS has a greater average velocity then the existing canal at maximum capacity of 450 CFS. The increased velocity may increase erosion in the channel. However, literature indicates that if the velocity in the clean/regraded canal stays below 2.5 to 3.0 FPS, erosion will be minimal.

C.6 Conclusion

The existing channel has been analyzed and has been found to have a maximum capacity of 450 CFS. This flow capacity is below the original design flow capacity of 496 CFS. If the existing canal is cleaned and regraded, the resulting canal will have a maximum capacity of 575 CFS. This analysis was based on a representative section of canal only. It is recommended that the entire canal be surveyed and analyzed before work is undertaken.